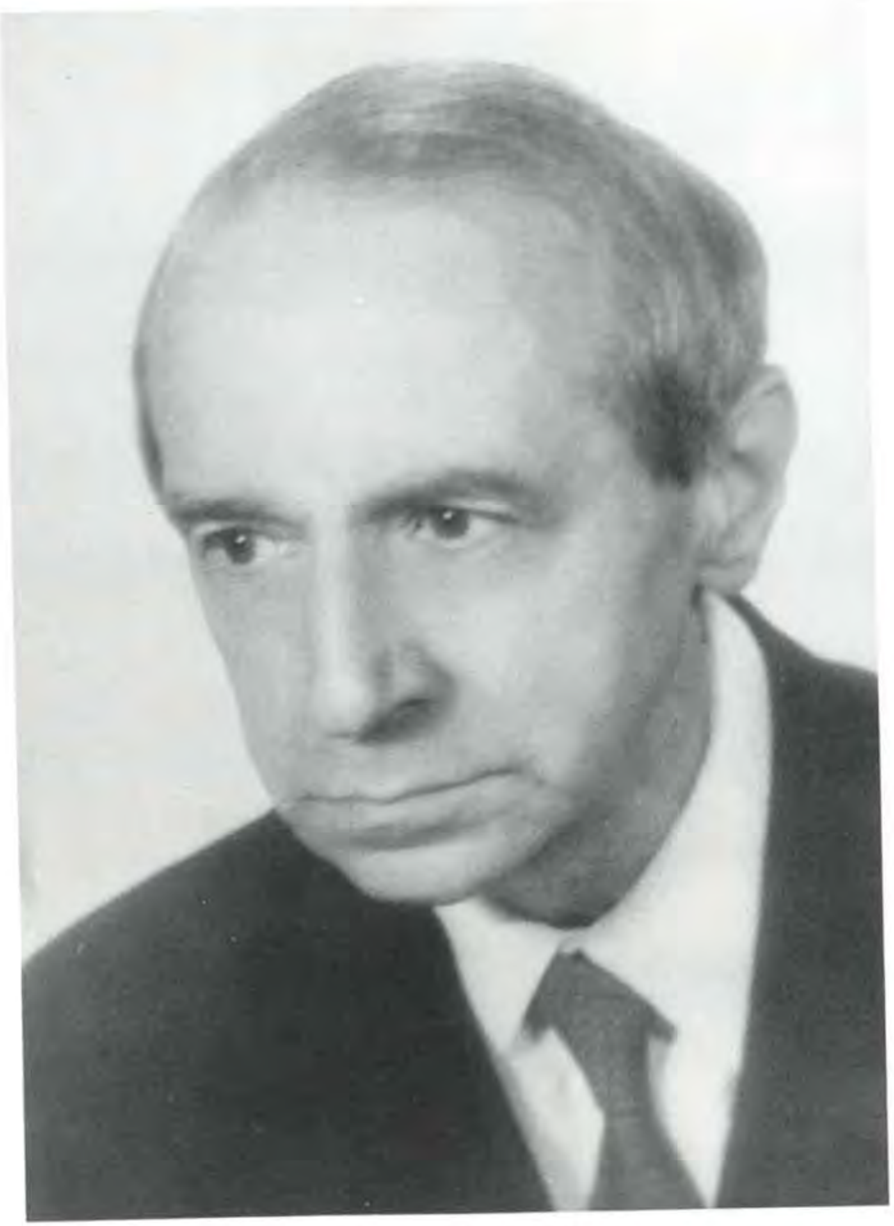

MICHAŁ KALECKI

Collected Works of

MICHAŁ KALECKI

VOLUME IV

SOCIALISM

Economic Growth and Efficiency of Investment

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List of Abbreviations

AKPRM	Archiwum Komisji Planowania przy Radzie Ministrów (Archives of the Planning Commission of the Council of Ministers)
CMEA	Council for Mutual Economic Assistance
CSP	Centralna Szkoła Partyjna (Central Party School at the Central Committee of the PUWP)
IASP	International Arts and Sciences Press
KC PZPR	Komitet Centralny Polskiej Zjednoczonej Partii Robotniczej (Central Committee of the Polish United Workers' Party)
KiW	Książka i Wiedza (Educational Books)
OUP	Oxford University Press
PWE	Państwowe Wydawnictwo Ekonomiczne (Polish Economic Publishers)
PWN	Państwowe Wydawnictwo Naukowe (Polish Scientific Publishers)
PWRiL	Państwowe Wydawnictwa Rolne i Leśne (State Agricultural and Forestry Publishers)
PZPR (also PUWP)	Polska Zjednoczona Partia Robotnicza (Polish United Workers' Party)
SGPiS	Szkoła Główna Planowania i Statystyki (Main School of Planning and Statistics, Warsaw)

List of Polish Journals

Dziennik Urzędowy Ministerstwa Finansów	Ministry of Finance Official Gazette
Dziennik Ustaw RP	Official Gazette of Polish Republic
Ekonomista	Economist
Gospodarka Planowa	Planned Economy
Inwestycje i Budownictwo	Investment and Construction
Kultura i Społeczeństwo	Culture and Society
Nowe Drogi	New Ways
Nowe Książki	New Books
Polityka	Politics
Materiały i Dyskusje, CSP, KC PZPR	Documents and Discussion Notes
Monitor Polski	Polish Monitor
Oeconomica Polona	
Prace i Materiały Międzyuczelniany Zakład Problemowy Gospodarki Krajów Słabo Rozwiniętych	Working Papers of the Centre of Research on Underdeveloped Economies
Prace i Materiały Zakładu Badań Ekonomicznych Komisji Planowania	Working Papers of the Economic Research Centre of the Planning Commission
Przegląd Statystyczny	Statistical Review
Trybuna Ludu	People's Tribune
Zastosowania Matematyki	Applications of Mathematics
Zeszyty Naukowe Uniwersytetu Łódzkiego	Working Papers of Łódż University
Życie Gospodarcze	Economic Review
Życie Warszawy	Life of Warsaw

Editor's Note

Volume iv of *Collected Works of Michał Kalecki* contains his studies in the theory of growth of a socialist economy and the theory of economic efficiency of investment; these are supplemented, in Part 3, by his essays on some economic and social problems of People's Poland.

Compared to volume iii of *Collected Works*, devoted mainly to the system of planning and management of the Polish economy in the years 1955–64, and to economic policy-making in that period, the essays published in this volume, especially in its first two parts, are of more theoretical nature. However, both the *Introduction to the Theory of Growth in a Socialist Economy*, as well as Kalecki's many studies in the theory of economic efficiency of investment projects, are deeply rooted in his practical experience as an economic planner; indeed, they represent a generalization of this experience (discussed in detail in *Collected Works*, vol. iii). It is only in this light that the significance of his contributions to the theory of growth in a socialist economy and the theory of economic efficiency of investments can be assessed, and his ideas on socialist reproduction can be seen as a whole. Its central point is economic planning, which for Kalecki was the fundamental feature of a socialist economy.

Kalecki's conference papers, memoranda, and those other contributions which are separate units, are published in Parts 1–3 of the present volume, or in the annexes (listed in the Table of Contents). His other contributions are extensively quoted in the editorial matter in the context of the discussions to which they pertain.

As in earlier volumes of the present edition, the purpose of the editorial matter is to place Kalecki's work in the context of the development of his theoretical thinking and that of others, and against the background of the actual economic situation and the institutional set-up of the times. However, for reasons explained in vol. iii of *Collected Works* (see p. xv–xvi), the editorial matter in the volumes on a socialist economy is greater in extent than in other volumes.

Apart from various archival material and Kalecki's own papers, verbal information obtained from Mrs Adela Kalecki and from Kalecki's friends and associates is used in this volume. In 1979–80 several leaders of the Polish economy in the years 1945–64 were interviewed by the editor of Kalecki's *Collected Works*; these interviews are also used in the editorial matter.

In accordance with the subject–chronological arrangement of the *Collected Works*, each part of the volume consists of essays devoted to a similar topic; individual papers in each part are arranged in chronological order. The editing principles followed throughout are given in full in the Editorial Note to vol. i; they will be only briefly summarized here.

Kalecki's texts are published following a final edition of each paper accepted by the author; more important differences between successive versions of the same paper are noted in editorial comments. Kalecki's footnotes—marked in each paper by successive numbers without parentheses—are placed at the foot of the page. Editor's comments—marked by successive numbers in square brackets within each paper, in the same way as reference to them in the text of Kalecki's essays—are placed at the end of the volume. The first comment on each paper contains information on its source of publication, its re-editions and translations, and usually also brief information on the background of the paper in question and the discussions associated with it; it is therefore of a more general nature. Other comments refer to more specific questions. Annexes, also placed at the end of the volume and meant as supplements to the basic texts, contain the more important extensions and explanations by Kalecki, strictly connected with a given work. In order to avoid repetition, the editor's comments on the first essay in a given part of the volume are even more general, providing *inter alia*, information on the relation of Kalecki's ideas, developed in essays constituting a given part of the volume, to the ideas of contemporary economic theory, economic discussions at the time, or the actual economic situation and policies.

In the Editorial Notes and Annexes Kalecki's own writings are printed in larger type, except for occasional short quotations used in editorial material to clarify the context; these are printed in smaller type.

I sincerely thank Professors Lidia Beskid, Wiktor Herer, Cezary Józefiak, Tadeusz Kowalik, Kazimierz Łaski, Jacek Marecki, Mieczysław Nasiłowski, Mieczysław Rakowski, and Władysław Sadowski, who gave friendly comments on the earlier versions of the editorial matter, and especially Włodzimierz Brus, Stanisław Gomułka, and Kazimierz Łaski, who helped to improve the present English edition of this volume.

I thank the various publishers of Kalecki who very generously granted their permission to reproduce these essays and papers in the *Collected Works of Michał Kalecki*. More specific acknowledgements are made in comments following individual papers.

J.O.

Warsaw
September 1990

PART 1

GROWTH THEORY

Introduction to the Theory of Growth in a Socialist Economy[1]

(1963)

Contents

Preface to the First Polish Edition
(1963)

In the title of this book the word 'introduction' must be emphasized. The theory of growth in a socialist economy is—or is going to be—a vast and complex field of study, while in this essay I concentrate upon a few fundamental and relatively simple problems.

One of the causes of the complexity of the dynamics of a socialist economy is the durability of capital equipment. Thus, for instance, changes in production methods affect new investment rather than the existing stock of equipment. Even the relatively simple problems analysed in this book appear to be so complicated that we confine ourselves to approximate solutions, for if we were to enter into all the intricacies and their implications, it would obscure the basic mechanism of the processes involved.

Another reason for the complexity of the problems of growth is the fact that the economy consists of many different sectors. We avoid this difficulty by means of some simplifying assumptions which enable us to treat the socialist economy as an entity (it is only in the last chapter that a two-sector model is introduced, and even there a far-reaching simplification is adopted). We try to do our best, however, to avoid deviating too much from the real world.

It should be noticed that the contents of my book is closely related to that of my essay 'Problems in the Theory of Growth of a Socialist Economy',[2] although it is by no means identical with it.

In the course of the past three years, partly in connection with my lectures on this subject in the Central School of Planning and Statistics, Warsaw, and my lectures at the University of Manchester in 1962, my theory has been significantly developed and improved. Nevertheless, as I have already pointed out, it represents merely the first approximation to the solution of some fundamental questions of the development of a socialist economy.

Preface to the Second Polish Edition
(1966)

The present edition contains some important revisions which, however, do not undermine the fundamental structure of my argument. They are of three types.

First of all, the argument has been made more precise by additional explanations provided in the main body of the book and in new footnotes. It has also been improved by some simplifications and development of the analysis.

Secondly, the subject of my investigation has been partly expanded by taking into account, in Chapters 8 and 9, the question of the optimum capital–output ratio and the optimum life-span of equipment, although the process of 'recasting' the capital stock is not elaborated there. The results of this analysis are then compared with those of the 'recasting' process, which was examined in detail in the first edition of this book. Next, in Chapter 10, after a critique of the Dobb–Sen theory which argues in favour of capital-intensive variants of production under unlimited supply of labour, the argument in favour of *reducing* the capital intensity of production is put forward. Finally, an appendix on the relationship between the concept of the curve of production and the calculation of the efficiency of investment is added.

Thirdly, some technical complications which do not contribute to the general understanding of my theory (for instance, the examination of the process of capital 'recasting' to an increased capital intensity of output under the difficulties in balancing foreign trade) are omitted here.

All these changes result from the comments of readers, especially Professor Kazimierz Łaski, and from my further studies in the theory of growth of a socialist economy.

1. Definitions and Assumptions

1. Since in this essay we shall be concerned with the long-run changes in the national income and its components, we shall start from a definition of these concepts.

We define the national income in a given year as the value of goods produced in that year after deducting the value of raw materials and semi-manufactures used in the process of production. The value of imported materials is subtracted because they are not produced in the country considered; the value of home-produced materials is deducted to avoid double counting. If in a given year machines are produced which require *inter alia* the production of a certain amount of steel, then by deducting the value of the steel input we avoid including the production of steel in the national income twice—first in the value of steel production, and second in that of machinery production. In this way the national income—as contrasted with the aggregate turnover—does not depend on the number of stages of production.

Inputs into the production process include not only raw materials and semi-manufactures, but also fixed capital. However, according to the definition given above, we do not deduct depreciation from the value of output and thus we are dealing with *gross* national income. This different treatment of materials on the one hand, and depreciation on the other, may seem to be inconsistent but in fact it is not. Depreciation as contrasted with the input of materials is not a strictly determined magnitude. The life-span of productive equipment is not a purely technological parameter but depends largely on a decision based on economic considerations. As we shall see below, dealing with the gross rather than with the net national income and investment brings this factor into focus.

It also follows from our definition of the national income that this concept includes the production of goods but not that of services, which is in line with the approach adopted in socialist countries. It is true that the production of services similar to goods, such as transportation, laundries, restaurants, and even trade is included. Excluded, however, from the national income are, on the one hand, government administrative services, education, entertainment, health, etc., and, on the other hand, the utilization by consumers of certain fixed assets, such as dwelling-houses or hotels. All such services are, however, accounted for in the national income statistics of capitalist countries, by including in the national income government expenditure on administration, public or private expenditure on education and health, and finally private expenditure on entertainment, rents, etc.

It appears that in the study of economic dynamics the treatment of national income as production of goods offers appreciable advantages. The measurement of changes in real values, i.e. values after elimination of price changes, is generally easier for goods than for services. For instance, in the statistics of capitalist countries the real increase in administrative activity is measured by an index of employment of government officials (weighted according to their wages in the basic year) and thus no account is taken of changes in labour productivity, i.e. in the number of man-hours required for the performance of a given operation, which obviously would be fairly difficult. The same problem also emerges to some extent in the measurement of services in education, entertainment, or health. From a different point of view it is inconvenient, in the analysis of economic growth, to include in the national income the services rendered by residential buildings, etc. Here, the ratio between the capital outlay and the value of services is very high in comparison to the corresponding ratio in the production of goods which, as we shall see, would considerably complicate the theory of growth. Obviously, this does not mean that services are to be neglected in long-run planning, but rather that they are planned not in terms of national income but either in terms of employment, e.g. administrative services, or in terms of capacity of fixed assets rendering consumer services, e.g. the services rendered by residential buildings.

2. In a closed economy the gross national income is divided, according to its final use, into the following components:

(i) Productive investment, i.e. outlays on reproduction and expansion of the stock of equipment (machinery and buildings) involved in the production of goods.

(ii) Increases in inventories, i.e. the value of the increment in working capital and stocks.

(iii) 'Non-productive' investment, i.e. outlays on new fixed assets which do not contribute to the production of goods—such as residential buildings, hotels, schools, hospitals, stadiums, streets, parks, etc.

(iv) Collective consumption which includes non-investment goods consumed by central and local government as well as by enterprises engaged in the production of services not included in the national income (for instance, stationery used in offices, medicines, food and linen used in hospitals, stage properties in theatres, etc.).

(v) Individual consumption of goods and similar services.

In an open economy it is necessary to add to the above (*f*) exports—i.e. the value of the output of goods which are sold abroad—and at the same time to deduct (*g*)—imports of raw materials, semi-manufactures, and finished goods, which are included in the components of the national income listed above but are not produced at home.

Thus the national income is divided as follows:

(i) Productive investment
(ii) Increases in inventories
(iii) Non-productive investment
(iv) Collective consumption
(v) Individual consumption
(vi) Exports
(vii) Less imports
= National income

As mentioned above, both investment and national income are gross of depreciation. Some further clarification of the treatment of capital under construction is required. In the statistics of both socialist and capitalist countries changes in work in progress in machine-building are accounted for in the increase in inventories, while those in the volume of buildings under construction are included in investment. For our purpose it will be more convenient to classify the latter item under increase in inventories as well. Investment in fixed capital is thus tantamount to the volume of new capital equipment delivered in a given year.

Among the components of the national income two broad classes may be distinguished: (i) those elements which serve as the *means* to increase the national income, i.e. productive investment and increases in inventories; (ii) those which are the *aim* of production of goods, i.e. non-productive investment and collective and individual consumption. We shall call the sum of productive investment and increases in inventories *productive accumulation*, and the sum of non-productive investment and consumption—*consumption* in the broad sense.

It remains debatable, to which class—that of means or that of aims—one should assign the difference between exports and imports, i.e. the balance of trade. Since it will be assumed below that the balance of trade is equal to zero, we shall not labour this point.

3. In order to compute the national income and its components as defined above, it must be specified at what prices the goods composing the national income should be valued. In the socialist economy two distinct sets of prices are used: factory prices and market prices. Factory prices are established at the level of average costs of production *plus* a small mark-up; market prices comprise, over and above this level, the turnover tax. Since, in practice, the turnover tax is levied mainly on consumer goods, the valuation of the national income at market prices leads to some distortions in its dynamics.

Let us suppose, for example, that a given number of workers, using a given machine, shifts from the production of investment goods to that of consumer goods. If market prices are used in the evaluation of national income, then the productivity of labour and machinery will show a spurious increase. Therefore, in studying the theory of economic growth, it is advisable to assume that national income and its components are computed at factory prices.

The next problem is the evaluation of the national income in consecutive years so as to calculate its 'real' growth, which is of interest in the study of economic dynamics. This may be achieved by valuing the national income and its components at constant prices, for instance at prices in the initial year. The method involves a certain difficulty with regard to the emergence of new products for which no prices existed in the base year. This difficulty may be dealt with by means of the following approximation. Suppose that the factory price of a new product A is,

say, 10% higher than that of a similar product B which existed in the initial year. We may assume that the 'base' price of A was equal to the 'base' price of B plus 10%. Such a method, however, may be difficult to apply to a period rather distant from the initial year, since it may not be easy to find in the initial year any product which would be close to A. Again, however, there is a way out. The new product in the year n is defined as one that did not exist in the year $n-1$; now, in the production of year $n-1$ we can find a product B which is close to it; this product B might itself have been a new product in some previous year, but its 'base' price has already been determined by means of our method. It is easy to see that if we start from the initial year and then move onwards from year to year, we shall find no difficulty in valuing the national income and its constituents at constant prices.

In addition to these general problems of valuation of the national income there are two more specific ones. One concerns the increase in inventories; the other, exports and imports. As regards the former it should be kept in mind that the value of inventories at the beginning and at the end of each year is to be computed in the prices of the initial year, and only after doing this may the difference between the two be calculated.

The price problems concerning exports and imports are more complicated. First we compute the value of exports in the initial year at factory prices. The ratio of this value to the foreign-exchange value of exports yields the so-called 'achieved rate of exchange'. The product of this rate and of the foreign-exchange value of imports yields in turn what may be called the 'value of imports at factory prices': it is the value of such exports expressed in factory prices which would buy a given volume of imports in the initial year. It should be noted that the relation between the values of exports and imports at factory prices in that year is the same as that between their respective values in foreign currency.

How should we value exports and imports of any year at the factory prices of the initial year? At first glance the following approach appears to be reasonable. Since foreign-exchange prices generally change both for exports and for imports, the value of exports is calculated at the export prices of the initial year, and the value of imports at the import prices of this year, i.e. as the 'real' values of exports and imports expressed in foreign exchange. These values are then multiplied by the 'achieved exchange rate' of the initial year and thus we obtain the values of exports and imports at the factory prices of that year.

This approach, however, has an important deficiency. If there occurs a change in the terms of trade, the ratio of export and import volumes arrived at by the above method would be different from the ratio of their actual foreign exchange values. In particular, these volumes would generally not be equal in the case of balanced foreign trade. Suppose, say, that in a given year both exports and imports amount to \$1.5 billion; that the index of export prices based on the initial year is 105, while that of import prices is 125; and that the 'achieved rate of exchange' for the initial year is zł. 30 per dollar. 'Real' exports then amount to $1.5/1.05 = \$1.43$ billion, and 'real' imports to $1.5/1.25 = \$1.2$ billion, while their respective values at factory prices of the initial year are zł. 43 billion and zł. 36 billion.

This discrepancy can be corrected as follows: the foreign currency 'real' value of imports is calculated in constant import prices of the initial year, but the 'real' value of exports in foreign currency is assumed to bear the same relation to 'real' imports as does the current foreign currency value of exports to that of imports. If this method is used in the preceding example, 'real' exports equal 'real' imports, i.e. \$1.2 billion. This method may be defined as deflating exports by the index of import prices rather than by that of export prices. In our example the export value—\$1.5 billion—is divided by 1.25 rather than by 1.05. Thus it is clear that if exports and imports are equal in current prices their 'real values' determined in this way will also be equal.

If the current exchange value of exports amounts to, say, 0.9 of that of imports (e.g. exports are equal to \$1.35 billion and imports to \$1.5 billion) the 'real' value of exports is determined as 0.9 of the 'real' value of imports. (If the index of import prices is 1.25, 'real' exports equal $0.9 \times 1.2 = 1.08$, or, what amounts to the same thing, $1.35/1.25 = \$1.08$ billion.) The 'real' value of exports thus defined indicates the value of imports at the base year's import prices which can be obtained in exchange for these exports. It is thus the so-called 'volume of the import equivalent of exports'. Finally, by multiplying the 'real' values of exports and imports by the 'achieved exchange rate' of the initial year we arrive again at the respective values at factory prices of that year.

It is obvious that the 'real' values of exports and imports—

which are components of the 'real' national income—are, by definition, proportional to their respective current values in foreign currency. Thus the equilibrium in the balance of trade will have its counterpart in the equality of the respective items in the 'real' national income accounts. Any difference between these items shows the amount of foreign lending or borrowing (more precisely, such difference is equal to the volume of the import equivalent of foreign credits multiplied by the 'achieved exchange rate' of the initial year). The advantages of this approach are obtained, however, at the expense of introducing a certain modification into the concept of national income: the volume of exports ceases to be what it was in the previous approach, i.e. a measure of export output; it becomes instead a measure of the volume of imports which this output can buy. Hence, if the volume of the national output remains unchanged, but there is a deterioration in the terms of trade, the national income decreases. Thus the national income no longer represents what is produced but what is received. This is not, however, a disadvantage at all from the point of view of the study of economic growth, as we shall see below. It appears that whenever in such an analysis we deal with the problem of foreign trade, it is convenient to have changes in the terms of trade reflected in changes in the national income.

It should be added that all the imported goods which enter into different components of the national income must be valued at the same prices at which they are priced when entering into the item 'imports'. This is because the sole purpose of the deduction of the latter item from the sum total of all other components of the national income is to eliminate from them all such elements which are not produced at home. This is not achieved if these elements are not priced at strictly the same prices.

4. Henceforward in our argument we shall assume that the country considered neither borrows from nor lends to other countries so that its foreign trade is balanced. From the above definitions it follows that in such a case exports and imports as items of the 'real' national income accounts are equal. Hence, national income will be the sum of productive accumulation and consumption in the broad sense. This definitely does not mean that in our argument we shall completely disregard the problems of foreign trade. On the contrary, as we shall see below, the necessity of balancing foreign trade plays an important part in our analysis of the determination of the rate of growth of national income.

5. The factory prices of the initial period at which, according to the above, the national income is evaluated are, broadly speaking, proportionate to the labour costs of the respective products. (Labour costs are assumed here to cover the labour required to produce materials used in the production of the goods considered.) It follows that the labour outlay per unit of national income is approximately equal for productive accumulation and for consumption in the broad sense in the initial period.[1]

Since in subsequent years the national income is expressed in factory prices of the initial period, the labour content per unit of national income in the two sectors will remain approximately equal only if labour productivity in these sectors increases *pari passu* so that the labour outlay per unit of national income in these sectors declines in the same proportion. (From the above argument on the subject of import prices there follows an additional condition for the approximate equality of the labour outlay per unit of national income for productive accumulation and for consumption: the foreign-exchange prices of imported goods for the two sectors must bear a stable relation to one another.)

It will be assumed below that these conditions are fulfilled in the process of growth with the result that the labour outlay per unit of national income in the sectors of productive accumulation and consumption remains approximately equal. Thus to any change in the relative shares of these items in the national income there corresponds a proportionate change in the distribution of employment between the respective sectors of the economy. This has an important bearing upon our subsequent discussion.

2. Basic Equations

1. As mentioned above, the components of productive accumulation, i.e. productive investment and increase in inventories, are a prerequisite for the growth of the national income. We shall

[1] Because of the difference in average wages this will be true only if we measure the labour outlay not in working hours but as an equivalent in terms of simple labour, i.e. by the ratio of the wage bill to the hourly wage for unskilled labour.

now determine the relationship between the increase in national income and these items.

Let us denote the national income in a given year by Y; productive investment by I; the increase in inventories, i.e. working capital and stocks, by S; and consumption in the broad sense by C. According to the above definitions and assumptions we have

$$Y = I + S + C \tag{1}$$

where $I + S$ is productive accumulation.

Let us now establish the relationship between the increment in national income on the one hand, and productive investment, and the level of national income on the other. We shall denote the increment in the national income from the beginning of a given year to the beginning of the next by ΔY. Let us assume that in the course of the year the national income remains constant so that the change occurs at the beginning of the following year. Thus ΔY is also the difference between the total national income of the given year and that of the following year. This increment is due, first of all, to the productive effect of investment, I, representing the volume of equipment delivered in the course of the first year; according to our assumption this yields production starting from the beginning of the following year. Let us denote by m the so-called capital–output ratio, i.e. the capital outlay per unit increment in national income. The productive effect of investment, i.e. the amount by which the national income is increased as a result of investment, is thus $(1/m)I$.

There are, however, other factors which affect the increment in the national income. First, capital equipment is subject to continuous obsolescence and wear and tear, which results in scrapping of obsolete equipment, and thus a contraction in productive capacity.[2] Owing to this factor, the national income declines at the beginning of the second year by an amount aY, a being a coefficient which will be called the 'parameter of depreciation'. This process has an opposite effect from the increase in national income resulting from productive investment.

[2] That part of wear and tear that is covered by current repairs (including spare parts) is deducted from the value of production, analogously to raw material inputs, in order to arrive at gross national income. Thus we are considering here only that part of wear and tear that occurs *despite* current repairs.

There is also a tendency for the national income to increase owing to improvements in the utilization of equipment which do not require significant capital outlays. Greater output may be obtained from existing plant due to improvements in the organization of labour, more economical use of raw materials, elimination of faulty products, etc. As a result of such efforts the national income increases at the beginning of the next year by an amount uY, u being the coefficient which represents the effect of such improvements.[3]

Thus we arrive at the following formula representing the increment in the national income ΔY as a function of investment I and the level of the national income Y in a given year

$$\Delta Y = \frac{1}{m} I - aY + uY \tag{2}$$

Let us divide both sides of equation (2) by Y

$$\frac{\Delta Y}{Y} = \frac{1}{m}\frac{I}{Y} - a + u$$

If we denote by r the rate of growth of the national income we obtain

$$r = \frac{1}{m}\frac{I}{Y} - a + u \tag{3}$$

2. At this point the question arises whether formula (3) may also be used for the analysis of the dynamics of a capitalist economy. The answer is in the negative; the difference between the capitalist and the socialist system will make its appearance in the interpretation given to the coefficient u.

In the socialist system the productive capacity is, at least in principle, fully utilized. Nevertheless owing to improvements in

[3] The coefficient u reflects *inter alia* progress made in avoiding bottlenecks, which hamper the full utilization of productive capacity. If, e.g. the productive capacity for good A is not dovetailed with that for good B, so that output of B lags behind that of A, this will inhibit the full utilization of the productive capacity for A. Such disproportions should not arise in a perfectly planned economy, but in practice differences in the fulfilment of plans for the production of particular commodities, imperfect foresight of developments in overseas markets, etc. make bottlenecks unavoidable. Progress in reducing these discrepancies will lead to a gradual improvement in the utilization of total capital equipment, and will thus account for part of u.

the organization of labour, to more economical use of raw materials, etc., a steady increase may be achieved in the national income through better use of existing equipment. If such progress goes on at a uniform rate, u remains constant.

By contrast, in the capitalist system the degree of utilization of equipment depends first and foremost on the relation between effective demand and the volume of productive capacity. Thus u is not an independent coefficient in this case but reflects changes in the degree to which it is possible to find a market for the output of the existing productive facilities. It is only in the socialist economy, where utilization of productive capacity is safeguarded by the plan (first and foremost by fixing an appropriate relation between prices and wages) that the coefficient u begins to reflect solely the effect of organizational and technical improvements which do not require significant capital outlays.

3. On the assumption of constant m, a, and u it follows directly from formula (3), that, if the relative share of investment in the national income I/Y remains unaltered, the rate of growth r does not change either. But the constancy of I/Y is tantamount to investment growing *pari passu* with the national income.

Thus if investment is increased at the same rate as the national income, a constant rate of growth of the latter is warranted. If, however, the former expands more rapidly than the latter so that its relative share in the national income is increasing, then according to formula (3), this permits the rate of growth of national income to rise steadily, i.e. it sustains accelerating growth.

All this is valid as long as the parameters m, a, and u remain unchanged. But is not the assumption of a constant capital–output ratio m in conflict with the very essence of technical progress which involves rising productivity of labour, accompanied by an increase in capital per worker?

However, the constancy of m merely means that the ratio of capital to output remains unchanged, which by no means excludes the possibility of a decrease in employment in relation both to output and to capital. In such a case employment would fall in the same proportion with respect both to capital and output, so that labour productivity would increase *pari passu* with the capital–labour ratio. Indeed, historical and statistical evidence, both from capitalist and socialist countries, shows that there is no need for the capital–output ratio m to increase in order to sustain a steady rise in labour productivity. These remarks on technical progress are merely introductory, and the problem will be treated in more detail in Chapter 7.

4. We shall now briefly consider the relationship between increments in national income and the other component of productive accumulation, i.e. the increase in inventories. We may assume that the volume of inventories, given the physical structure, rises proportionally to the national income, so that the increase in inventories, S, is proportional to the increment in the national income

$$S = \mu \Delta Y \tag{4}$$

where μ is the ratio between the volume of inventories and the national income, i.e. the so-called 'average period of turnover' of inventories.

The period of turnover of inventories will be different for different goods, from which it follows that the coefficient μ depends upon the physical structure of the increase in inventories. In what follows we shall disregard the effect of changes in this structure upon the parameter μ. It should, however, be noted that this is a rather far-reaching simplification—the more so if it is recalled that inventories are meant to include the volume of capital under construction. The ratio between this volume and current outlays on construction being relatively high, shifts from consumption to investment in the composition of national income—with which we shall deal frequently in our discussion—must lead to an increase in μ. In accordance with the assumption made above, however, for the sake of simplicity we shall not take this into account.

It should be noted that a similar simplifying assumption is made with regard to the capital–output ratio, m, which also depends on the structure of investment. It is true that the coefficient m, in contrast to μ, does not necessarily increase when there is a shift from consumption to investment in the composition of national income, since the production of finished investment goods, such as machinery and buildings—integrated over all stages of production—is hardly more capital-intensive than that of consumer goods. (On the other hand, the capital–output ratio is generally

higher in primary products than in higher stages of production.) In any case, in our analysis we disregard the effects of changes in the structure of investment on the capital–output ratio m.

5. Starting with equations (3) and (4) we may now establish the relationship between the rate of growth of national income and the relative share of productive accumulation in the national income. Equation (3) may be rewritten as follows

$$\frac{I}{Y} = (r + a - u)m$$

and equation (4) in the form

$$\frac{S}{Y} = \frac{\mu \Delta Y}{Y} = \mu r$$

By adding these equations we obtain

$$\frac{I+S}{Y} = (m + \mu)r + (a - u)m$$

and thus

$$r = \frac{1}{m+\mu} \cdot \frac{I+S}{Y} - \frac{m}{m+\mu}(a-u) \tag{5}$$

$I + S$ is productive accumulation, and we denote by i its relative share in the national income, i.e.

$$i = \frac{I+S}{Y}$$

Since the national income Y is the sum of productive accumulation, $I + S$, and consumption in the broad sense, C, the relative share of consumption in national income will be

$$\frac{C}{Y} = 1 - i \tag{6}$$

For the sake of brevity, we shall call the relative share of productive accumulation in the national income the 'rate of productive accumulation'. Let us, moreover, denote $m + \mu$ by k; we shall call k the 'capital–output ratio for total capital', since it indicates the amount of fixed capital and inventories required to produce a unit increment in the national income. By introducing these symbols in equation (5) we obtain

$$r = \frac{i}{k} - \frac{m}{k}(a - u) \tag{7}$$

It will be seen from this equation that, if the parameters k, m, a, and u remain constant, in order to sustain a constant rate of growth the relative share of productive accumulation in the national income must be kept at a constant level. This means that, in the case of a constant rate of growth, productive accumulation increases *pari passu* with the national income, i.e. at a rate r.

It has been demonstrated above that in such a case productive investment increases in step with the national income; thus the same must be true of the other component of productive accumulation, i.e. the increase in inventories. Moreover, since the relative share of consumption in the national income, $1 - i$, also stays constant, it is clear that consumption also rises *pari passu* with the national income.

If, however, the growth in the national income is accelerated, i.e. the rate r is rising, the relative share of productive accumulation in national income, i, must also rise. Thus, in this case, productive accumulation rises more rapidly than the national income, while consumption grows more slowly, its share in the national income, $1 - i$, showing a steady decline.

The higher the constant rate of growth of national income r, the greater must be the share of productive accumulation i in national income, and the lower the relative share of consumption $1 - i$. This fact alone points to certain limitations in the choice of a rate of growth. If this rate is raised the relative share of consumption in the national income must be reduced, which adversely affects the level of consumption in the short run. This is one of the factors which must be taken into account when making a decision on the rate of growth. The determination of the rate of growth (which also depends upon the balance of manpower and the balance of trade) is the main topic of this book, but, before concentrating upon it, it is useful to examine more closely the process of economic growth characterized by a *given*, constant rate of growth r.

3. Uniform Growth

1. We shall now consider the process of economic growth given the following assumptions:

(i) The rate of growth, r, of the national income is constant.
(ii) The parameters m, k, a, and u remain unaltered.
(iii) The productivity of labour in new plant which is brought into operation in successive years increases at a constant rate α owing to technical progress (inclusive of organizational progress). In other words, the productivity of labour in the establishments brought into operation in a given year is $(1 + \alpha)$ times higher than that in the establishments brought into operation in the preceding year. (In accordance with the assumptions made at the end of Chapter 1 we postulate that the rate of the increase in productivity of labour is the same for the sector of productive accumulation and that of consumption in the broad sense.)

It follows from assumptions (i) and (ii) that productive accumulation and its components—productive investment and increase in inventories—as well as consumption rise at a constant rate r. We shall now prove that the same is true of the stock of fixed capital K, provided that its life-span, n, remains unchanged.[4]

The stock of fixed capital existing at a given time consists of investment carried out in the course of the preceding n years, since all plant constructed earlier has already gone out of use. Let us denote by K_t the stock of fixed capital at the time t; by I_1 investment in the first year of the n-year period preceding the moment t; by I_2 investment in the second year of this period and so on. Thus we have

$$K_t = I_1 + I_2 + I_3 + \ldots + I_n$$

Since investment increases at the annual rate r, we obtain

$$K_t = I_1[1 + (1 + r) + (1 + r)^2 + \ldots + (1 + r)^{n-1}] \tag{8}$$

Shifting the sequence of investment by one year, we obtain for time $t + 1$

$$K_{t+1} = I_2 + I_3 + I_4 + \ldots + I_{n+1}$$
$$= I_2[1 + (1 + r) + (1 + r)^2 + \ldots + (1 + r)^{n-1}]$$

Dividing this equation by the preceding one we arrive at

$$\frac{K_{t+1}}{K_t} = \frac{I_2}{I_1}$$

[4] As we shall see in n. 5 below the constancy of this life-span is inherent in the constancy of the rate of growth r and the parameters a and u. If n varied with constant r and u, the parameter of depreciation a would also vary.

Since I_2 is the investment made a year later than I_1, and investment increases at the annual rate r it follows that

$$\frac{K_{t+1}}{K_t} = 1 + r \qquad (9)$$

Thus the stock of fixed capital also increases at a rate r.

It is of interest now to find the relationship between the national income and the stock of fixed capital. Our discussion of this relationship will serve also to prepare the ground for the solution of our next problem: that of the rate of growth of average labour productivity for the economy (our assumption on the uniform growth of the productivity of labour pertains only to productivity in the new establishments brought into operation in successive years).

2. Let us consider the output which corresponds to each of the components of the stock of fixed capital K_t, i.e. to $I_1, I_2, \ldots, I_n$ in the year $t + 1$. The equipment represented by these investment outlays yielded—according to our definition in section 1 of Chapter 2—at the beginning of the next year the output

$$\frac{1}{m} I_1, \ \frac{1}{m} I_2, \ldots, \ \frac{1}{m} I_n$$

respectively (where m is the capital–output ratio). With the lapse of time, however, owing to improvements in the utilization of equipment, the respective outputs were increasing every year at a rate u during the subsequent lifetime of the plant. Now, the equipment represented by investment in the first year of the n-year period which preceded the moment t, i.e. by I_1, was kept in operation up to the time $t + 1$, i.e. for n years. Similarly, equipment represented by investment of the next year, i.e. by I_2, was kept in operation for $n - 1$ years; that of the third year for $n - 2$ years; and so on. Consequently, in the year $t + 1$ the output of the plant represented by investment I_1 will be

$$\frac{1}{m} I_1(1 + u)^{n-1}$$

that of I_2 will be

$$\frac{1}{m} I_2(1 + u)^{n-2}$$

etc. Hence, aggregate output or national income, in the year $t + 1$ amounts to

$$Y_{t+1} = \frac{1}{m} I_1(1 + u)^{n-1} + \frac{1}{m} I_2(1 + u)^{n-2} + \ldots + \frac{1}{m} I_n$$

Taking into consideration that investment increases at an annual rate r, we obtain for the national income[5]

$$Y_{t+1} = \frac{1}{m} I_1 \,[(1 + u)^{n-1} + (1 + r)(1 + u)^{n-2} + (1 + r)^2(1 + u)^{n-3} + \ldots + (1 + r)^{n-1}] \qquad (10)$$

Dividing equation (10) by equation (8) we obtain the ratio between the national income in the year $t + 1$ and the stock of fixed capital at time t

$$\frac{Y_{t+1}}{K_t} = \frac{1}{m} \frac{(1 + u)^{n-1} + (1 + r)(1 + u)^{n-2} + \ldots + (1 + r)^{n-1}}{1 + (1 + r) + \ldots + (1 + r)^{n-1}} \qquad (11)$$

[5] This formula may serve to obtain an expression for the parameter a as a function of n, r, and u. As defined above, a is the ratio of the decrement of national income, which results from discarding old equipment, to the national income. This decrement is equal to the output of the oldest generation of plant, i.e.

$$\frac{1}{m} I_1(1 + u)^{n-1}$$

Dividing this expression by the value of the national income as given by formula (10) we obtain

$$a = \frac{\frac{1}{m} I_1(1 + u)^{n-1}}{\frac{1}{m} I_1(1 + u)^{n-1} + (1 + r)(1 + u)^{n-2} + \ldots + (1 + r)^{n-1}]}$$

$$= \frac{1}{1 + \frac{1 + r}{1 + u} + \left(\frac{1 + r}{1 + u}\right)^2 + \ldots + \left(\frac{1 + r}{1 + u}\right)^{n-1}}$$

and, after having summed the geometrical progression in the denominator,

$$a = \frac{r - u}{\left[\left(\frac{1 + r}{1 + u}\right)^n - 1\right](1 + u)}$$

As will be seen from this formula, n is fully determined by a, r, and u. Hence from the assumption that the latter are constant it follows that the life-span of equipment also remains unaltered (cf. n. 4 above).

It is immediately obvious that this ratio does not depend upon t, in other words it remains constant. This was to be expected, since we made the assumption that the national income grew at an annual rate r and we proved that the same was true for the stock of fixed capital. It will be noticed, moreover, that each term in the numerator of the fraction by which $1/m$ is multiplied, is greater than the corresponding term of the denominator (e.g. $(1 + u)^{n-1} > 1$, etc.). Thus the numerator is greater than the denominator and, consequently, the ratio of the national income to the stock of fixed capital is greater than the reciprocal of the capital–output ratio

$$\frac{Y_{t+1}}{K_t} > \frac{1}{m}$$

This obviously results from the improvement in the utilization of the old equipment at an annual rate u. If u equals zero, it follows from formula (11) that[6]

$$\frac{Y_{t+1}}{K_t} = \frac{1}{m}$$

3. Let us now consider the problem of the increase in the average productivity of labour for the economy as a whole. It was assumed above that labour productivity in plants brought into operation in successive years increases at a constant rate, i.e. that in any given year it is higher than it was a year before in the proportion $(1 + \alpha)$. Now, the output produced by new plant in any given year is $(1 + r)$ times greater than that which came out of new plant in the preceding year, since investment increases at an annual rate r and the capital–output ratio m is constant. But, if both output and labour productivity increase at constant rates in the new plants brought into operation each year, the same must be true

[6] It may seem strange that greater output per unit of investment is produced from old machinery than from new. First of all, it is quite possible that the production process has been more fully mastered with older equipment. This, however, is only a minor factor in explaining the 'paradox'; in reality many of the improvements in the utilization of equipment and organization of labour are also adopted with new equipment. The constancy of m means that if this factor were not taken into account in the capital–output ratio, it would have to increase over time. This also explains another 'paradox': that the ratio of the national income to aggregate fixed capital remains unaltered despite a steady improvement in the utilization of equipment.

of employment. Indeed, if we denote the rate of increase in employment in new plant by ε we may write

$$1 + \varepsilon = \frac{1 + r}{1 + \alpha} \tag{12}$$

Fixed capital at the time t consists, as we explained above, of equipment represented by investment $I_1, I_2, \ldots, I_n$. Let us denote by $z_1, z_2, \ldots, z_n$ the corresponding levels of employment immediately after the new equipment is brought into operation. It follows from the above that these levels of employment represent a geometrical progression with a ratio $1 + \varepsilon$. Let us for a moment make an assumption which will substantially simplify the argument. According to the above, output from existing plant increases at an annual rate u, e.g. owing to improvements in the organization of labour. Let us assume that the productivity of labour in existing plants rises at the same rate u, so that employment remains unchanged from the time they were brought into operation. In this special case, the levels of employment which correspond to the equipment represented by investment I_1, $I_2, \ldots, I_n$, are at time t the same as at the time when the respective plants were brought into operation, i.e. they remain equal to $z_1, z_2, \ldots, z_n$. Hence, total employment at the time t (denoted by Z_t) is

$$Z_t = z_1 + z_2 + z_3 + \ldots + z_n$$

But since $z_1, z_2, \ldots, z_n$ represent a geometrical progression with a ratio $1 + \varepsilon$ we have

$$Z_t = z_1 [1 + (1 + \varepsilon) + (1 + \varepsilon)^2 + \ldots + (1 + \varepsilon)^{n-1}] \tag{13}$$

Similarly, for the time $t + 1$ we obtain

$$Z_{t+1} = z_2 [1 + (1 + \varepsilon) + (1 + \varepsilon)^2 + \ldots + (1 + \varepsilon)^{n-1}]$$

and, dividing the latter equation by the former,

$$\frac{Z_{t+1}}{Z_t} = \frac{z_2}{z_1}$$

But since z_2 represents employment in establishments brought into operation a year later than those represented by z_1 we have

$$\frac{Z_{t+1}}{Z_t} = 1 + \varepsilon \tag{14}$$

Thus, aggregate employment increases at a rate ε, i.e. *pari passu* with employment in the new establishments brought into operation. This is exactly analogous to the relation between the stock of fixed capital and investment, which both increase at a rate r.

Moreover, since the national income increases annually in the proportion $1 + r$ and total employment in the proportion $1 + \varepsilon$, overall labour productivity increases annually in the proportion $(1 + r)/(1 + \varepsilon)$ and thus according to equation (12) in the proportion $1 + \alpha$, i.e. *pari passu* with labour productivity in new plants as they are brought successively into operation. It should be recalled that this is valid only in the case of uniform growth considered in this chapter. However, as we shall prove below, this result does not depend on our temporary assumption that labour productivity in existing plants increases at the same rate u as the output of these plants.

4. In fact the productivity of labour working with old equipment does not necessarily increase at a rate u. If, for example, the run of machines is accelerated, this does not necessarily mean that productivity of labour is increased in the same proportion, as it may prove necessary to hire additional workers. On the other hand, increased intensity of labour may not lead to an increase in output but to a reduction of employment; this is the case where, for example, an increased number of looms is run by each worker. In the general case, therefore, labour productivity in old establishments will be rising at a rate w different from u. As a result, employment in the old establishments does not remain stable, but changes in the proportion $(1 + u)/(1 + w)$ p.a.[7] It follows that employment levels on machinery of different ages at the time t are not $z_1, z_2, \ldots, z_n$ but

$$z_1\left(\frac{1+u}{1+w}\right)^{n-1}, \quad z_2\left(\frac{1+u}{1+w}\right)^{n-2}, \ldots, \; z_n$$

while aggregate employment Z_t is

$$Z_t = z_1\left(\frac{1+u}{1+w}\right)^{n-1} + z_2\left(\frac{1+u}{1+w}\right)^{n-2} + \ldots + z_n$$

[7] If $w > u$, this augments the supply of labour for employment in new plant; if $w < u$, the reverse is the case.

Finally, taking into acount that $z_1, z_2, \ldots, z_n$ form a geometrical progression with a ratio $1 + \varepsilon$ we obtain

$$Z_t = z_1\left[\left(\frac{1+u}{1+w}\right)^{n-1} + (1+\varepsilon)\left(\frac{1+u}{1+w}\right)^{n-2} + \ldots + (1+\varepsilon)^{n-1}\right] \quad (15)$$

(The formula we arrived at is analogous to formula (10) for the national income.) Similarly, for time $t + 1$ we obtain

$$Z_{t+1} = z_2\left[\left(\frac{1+u}{1+w}\right)^{n-1} + (1+\varepsilon)\left(\frac{1+u}{1+w}\right)^{n-2} + \ldots + (1+\varepsilon)^{n-1}\right]$$

and, dividing this equation by the former,

$$\frac{Z_{t+1}}{Z_t} = \frac{z_2}{z_1} = 1 + \varepsilon \quad (14')$$

Thus we have obtained the same result as in the special case previously considered; again, the overall productivity of labour increases from year to year in the proportion

$$\frac{1+r}{1+\varepsilon} = 1 + \alpha \quad (12')$$

Hence, total employment and the overall productivity of labour increase *pari passu* with employment and labour productivity in new plant.

5. According to our assumptions of uniform growth, the rate of growth of the national income r, and the parameters m, k, u, and a, as well as the rate of increase of labour productivity in the new plants brought into operation, α, are constant. We have also proved that the overall labour productivity increases at a rate α. We shall now make the additional assumption that full employment prevails in the economy. We shall write β for the rate of growth of manpower.

The rate of increase in employment denoted above by ε concerns in fact merely the employment in the production of goods. We shall assume, however, that employment in services increases *pari passu*, i.e. at a rate ε. For full employment to be maintained, the rate of growth of employment must be equal to that of manpower, and so we have

$$\varepsilon = \beta \quad (16)$$

and

$$1 + r = (1 + \alpha)(1 + \beta) = 1 + \alpha + \beta + \alpha\beta \qquad (17)$$

Since we postulated the constancy of the two rates of growth—that of national income, r, and that of labour productivity, α—as a characteristic of uniform growth, under full employment we must also postulate the constancy of β. The annual rates of growth α and β being rather small fractions, we may disregard their product $\alpha\beta$ in equation (17), and write the latter in an approximate form

$$r = \alpha + \beta \qquad (17')$$

Thus, the rate of growth of national income r is determined jointly by α which depends upon technical progress and β (which depends upon the natural rate of growth of the labour force). On the other hand, given the parameters m, k, u, and a, the rate of growth r determines the constant share of productive accumulation, i, in the national income, which is necessary in order to sustain it, on the basis of the equation

$$r = \frac{1}{k}\, i - \frac{m}{k}\,(a - u) \qquad (7)$$

This determination of i is represented graphically in Fig. 1 where i is plotted as the abscissa, and r as the ordinate.

The straight line representing the linear function given by formula (7) has the slope $1/k$ and intersects the r-axis at a point C situated at a distance $m/k(a - u)$ below the origin.[8] The rate of productive accumulation which corresponds to the rate of growth $r = \alpha + \beta$ is $i = 0A$.

As long as our two conditions—that of constancy of the parameters m, k, a, and u, and that of full employment—are fulfilled, acceleration of growth over and above the rate r is impossible, since it would come up against the barrier of a manpower shortage. There would, therefore, be no sense in raising the relative share of productive accumulation in the national income in order to accelerate the rate of growth. In these circumstances it would lead only to the creation of idle productive capacity.

It is obvious that when we remove our rigid assumptions as to

[8] This is the case when $a - u > 0$. If $a - u < 0$ the point C is, of course, situated above the origin 0.

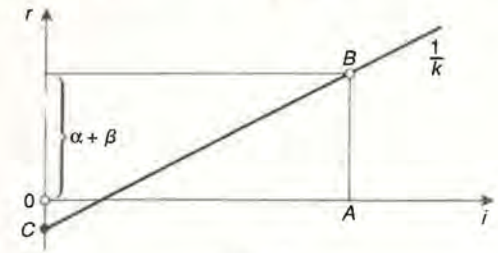

FIG. 1

the constancy of parameters and full employment, the problem of the choice of a rate of growth will emerge. We shall deal with this in the chapters that follow. We shall begin by examining the situation where there is a reserve of labour. We shall then proceed to discuss the case where no such reserve exists, and where in order to accelerate the rate of growth, it is necessary to overcome the shortage of labour—for example by raising the capital–output ratio.

4. Increasing the Rate of Growth of National Income under Conditions of an Unlimited Supply of Labour

1. With constant parameters m, k, a, and u, and under conditions of full employment, the rate of growth of national income cannot, as was shown above, exceed the level $\alpha + \beta$, where α stands for the rate of increase of productivity and β for that of the labour force. Any higher rate would prove impossible because of the emergence of a shortage of labour. We shall now consider a situation characterized by the existence of a reserve of manpower, e.g. married women who would be willing to take up jobs if these were easily accessible, some surplus of labour in agriculture, etc. By drawing on such reserves it is possible to raise the rate of growth of employment above β, and thus raise the rate of growth of the national income r above $\alpha + \beta$. It is obvious that this merely shifts the barrier of the supply of labour through time; when the reserve is exhausted we go back to the situation in which the rate of growth is $r_0 = \alpha + \beta$. However, the consequence of the higher rate of growth during the period over which the labour reserve is being absorbed will be to achieve an additional increase in the level of the national income.

2. In order to simplify the problem we shall initially ignore the possibility of exhausting the labour reserve, i.e. we assume that the reserve is so large that it cannot be exhausted even within a very long period of time. We thus disregard temporarily all problems related to the barrier of labour shortage, which enables us to concentrate upon other factors limiting the rate of growth.

Such a basic factor is that in order to raise the rate of growth r it is necessary—according to equation (7)—to increase the rate of productive accumulation i (i.e. the relative share of productive accumulation in the national income). Let us denote by i_0 the rate of productive accumulation which corresponds to the rate of growth of national income $r_0 = \alpha + \beta$. If, by raising the rate of growth of employment, we increase the rate of growth of the national income to the level $r = 0L$, then i must be raised from $0A$ to $0M$ (see Fig. 2).[9]

But the rise in the relative share of productive accumulation in the national income means, of course, an equal decline in the relative share of consumption. This deterioration in the consumption situation in the short run is the price to be paid for increasing the rate of growth of the national income, and thus also the level of consumption in the long run, the latter being favourably

[9] This is a slightly oversimplified presentation of the problem of raising the rate of growth of the national income. In order to increase r to the level $0L$, the rate of productive accumulation i is initially increased, as mentioned in the text, to the level $0M$. It is, however, apparent that as a result of the more rapid increase in the national income, while the life-span of equipment remains unaltered at n, the straight line CN will be shifting upwards (keeping the same slope), because the depreciation parameter a in the equation

$$r = \frac{1}{k}\, i - \frac{m}{k}\,(a - u)$$

will be declining. Indeed, a could only remain constant if the rate of growth also remained constant at r_0; the increase in the rate of growth to the level $0L$ means that the scrapping of old productive capacity which corresponds to the life-span u will be associated with a higher level of national income than would have been the case had the rate of growth been maintained at the level r_0. Thus CN shifts upwards, and the rate of accumulation i is somewhat lower than $0M$. This situation will continue for n years, at the end of which time all the equipment constructed before the raising of the rate of growth will have been scrapped. The rate of accumulation will then return towards the level $0M$ and, after some fluctuations, will eventually be stabilized. (Its level will, however, still be a little lower than $0M$, because with uniform growth a is a decreasing function of r; cf. n. 5 above.)

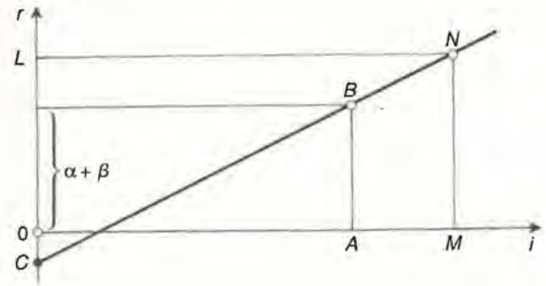

FIG. 2

affected by the cumulative effect of a higher rate of growth of national income. Thus the decision as to the level of r involves a compromise between the adverse short-run and favourable long-run effect of the higher rate of growth. Before embarking upon the analysis of the process of making this decision we must analyse more precisely the effects of a higher or lower rate of growth upon consumption.

3. Let us suppose that the national income grows at a constant rate r. At time t it will therefore equal $Y_0(1 + r)^t$, where Y_0 is the initial level of income. Since the relative share of consumption in the national income is maintained at $1 - i$, the level of consumption at time t will be $(1 - i)Y_0(1 + r)^t$. If the rate of growth is raised to r', the relative share of accumulation in the national income must correspondingly be increased to i', so that after t years the level of consumption will be $(1 - i')Y_0(1 + r')^t$. If we denote by C_t and C_t' the alternative levels of consumption at time t, we have the following relationships

$$C_t = Y_0(1 - i)(1 + r)^t$$
$$C_t' = Y_0(1 - i')(1 + r')^t$$

These equations can be represented diagrammatically, for which purpose it is more convenient to work with the logarithms of consumption. We have

$$\log C_t = \log Y_0 + \log(1 - i) + t \log(1 + r)$$

and

$$\log C_t' = \log Y_0 + \log(1 - i') + t \log(1 + r')$$

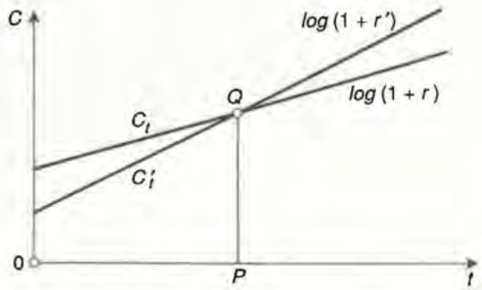

FIG. 3

to which correspond in Fig. 3 the straight lines C_t and C_t', with slopes $\log(1 + r)$ and $\log(1 + r')$ respectively.

It is apparent that with a higher rate of growth the level of consumption is less favourable over the period $0P$, i.e. the abscissa of the point of intersection Q, and more favourable thereafter; the relative advantage is the higher, the more remote the period considered. This demonstrates the conflict between consumption in the short period and in the long period.

4. The decision concerning the rate of growth can be approached in the following way. Let us suppose that a certain rate of growth t is considered admissible, and raising the rate to $r + \Delta r$ is under examination, where Δr is a small increment. This would imply the necessity of increasing the rate of productive accumulation by Δi. If we denote the present level of national income by Y_0, then consumption is equal to $(1 - i)Y_0$; thus it will have to be reduced by a fraction $\Delta i/(1 - i)$. This is the loss which must be compared with the advantage of increasing the rate of growth by Δr. We may write that on balance the net advantage is

$$\Delta r - \omega \frac{\Delta i}{1 - i}$$

where ω is a coefficient which is the higher the stronger are the objections against reducing consumption in the short run. If our problem is that of deciding how far the rate of growth is to be raised above the level $r_0 = \alpha + \beta$, we may postulate that ω will be the higher, the greater becomes the difference between i and i_0. Indeed, the further we move away from the initial situation, the

more important become the objections against further reducing the relative share of consumption in the national income.

Thus we may rewrite the above expression as follows

$$\Delta r - \frac{\omega(i)}{1 - i} \Delta i \tag{18}$$

where $\omega(i)$ is an increasing function. If this expression is positive, it is advisable to raise i up to the point at which

$$\Delta r - \frac{\omega(i)}{1 - i} \Delta i = 0$$

or

$$\frac{\Delta r}{\Delta i} = \frac{\omega(i)}{1 - i} \tag{19}$$

This is the condition which determines the 'correct' i. The ratio $\Delta r/\Delta i$ is simply the yield in terms of an increase in the rate of growth of national income, Δr, of raising the rate of accumulation by Δi.

We shall now represent diagrammatically the process of determining the rate of accumulation and the rate of growth. The diagram consists of two parts: the upper part is identical with Fig. 2 and in the lower part we plot i as the abscissa (as in the upper part of the diagram), whilst as the ordinate we have $\Delta r/\Delta i$. To the straight line BN, which represents the relationship between r and i in the upper part of the diagram, there corresponds a horizontal line $B'N'$ in the lower part. The distance between the latter and the i-axis is $1/k$, for this is the slope of the straight line BN. This represents the magnitude of $\Delta r/\Delta i$ as determined by equation (7). The curve $D'K'$ represents the function $\omega(i)/(1 - i)$. Since $\omega(i)$ is assumed to be an increasing function and the denominator $1 - i$ decreases when i rises, $\omega(i)/(1 - i)$ is also an increasing function and the curve $D'K'$ is upward sloping. This curve intersects the horizontal straight line $B'N'$ at the pont P' (see Fig. 4).

For all values of i lower than the abscissa of this point we have

$$\frac{\Delta r}{\Delta i} = \frac{1}{k} > \frac{\omega(i)}{1 - i}$$

and hence

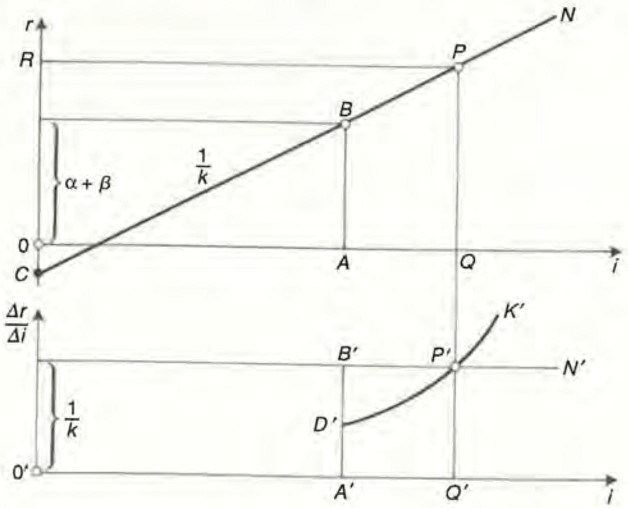

FIG. 4

$$\Delta r - \frac{\omega(i)}{1-i}\Delta i > 0$$

This means that the advantages are greater than the disadvantages and it is advisable to raise the rate of growth at the expense of an increase in the accumulation. The point P' represents the fulfilment of condition (19). The corresponding value of the rate of productive accumulation $0'Q'$ should not be exceeded, since any excess would mean

$$\Delta r - \frac{\omega(i)}{1-i}\Delta i < 0$$

We shall find r by projecting the point P' on to the straight line BN in the upper part of the diagram; this gives us the point P whose ordinate $0R$ is equal to r. We shall call the curve $D'K'$ the 'government decision curve', since it shows what value of $\Delta r/\Delta i$ will satisfy the government for a given i. Hence, together with the value of $\Delta r/\Delta i$ which is determined by the conditions of production (in our case by the value of the capital–output ratio k), it forms the basis for the decision as to the rate of productive accumulation i and the rate of growth r.

5. So far, for the sake of simplicity, we have presented the process of increasing the rate of productive accumulation as an abrupt reduction of consumption from the initial position. If such were in fact the case, the decision curve would slope upwards rather steeply with the result that the rate of growth decided upon would be not much higher than $r_0 = \alpha + \beta$, for any large increase in i would lead to a prohibitive deterioration in current consumption, and consequently in real wages.

This difficulty may be avoided if the relative share of productive accumulation in the national income is raised gradually. Let us suppose that consumption increases in step with employment. It follows that the ratio of the national income to consumption increases more rapidly because of the rise in productivity of labour at a rate α p.a. At time t this ratio will have increased in the proportion $(1 + \alpha)^t$. Initially the relative share of consumption in the national income is $1 - i_0$. If the relative share of productive accumulation in the national income is raised to i, the share of consumption must, of course, decline to $1 - i$. The ratio of the national income to consumption is then to be increased from $1/(1 - i_0)$ to $1/(1 - i)$, i.e. in the proportion $(1 - i_0)/(1 - i)$. We can achieve this by raising consumption *pari passu* with employment rather than with the national income for a sufficiently long period. The length of this transition period τ is determined by the equation

$$(1+\alpha)^\tau = \frac{1-i_0}{1-i}$$

or

$$\tau \log(1+\alpha) = \log\frac{1-i_0}{1-i}$$

From this we obtain

$$\tau = \log\frac{1-i_0}{1-i}\,\frac{1}{\log(1+\alpha)}$$

Since α is a small fraction, the term $\log(1 + \alpha)$ is approximately equal to α ('log' here means the natural logarithm). We thus obtain the following approximation

$$\tau = \frac{1}{\alpha}\cdot\log\frac{1-i_0}{1-i} \qquad (20)$$

which shows that τ is approximately proportionate to the reciprocal of the rate of growth of the productivity of labour.[10]

This result is of some significance for our argument. If we assume that the restraining of consumption which is necessary to increase the rate of growth is carried out in the way outlined above, the objections against raising the relative share of productive accumulation in the national income will be the stronger, the longer is the period τ during which real wages do not rise. But since the length of the period is proportional to the reciprocal of the rate of growth of productivity α, the coefficient $\omega(i)$ for a given i will be the higher, the lower is α. In other words, the lower the rate of increase in productivity of labour, the higher the ordinates of the curve $D'K'$ corresponding to given levels of the rate of productive accumulation. As a result the lower the rate of increase in productivity α, the lower will be the level chosen for the rate of growth r as determined by the point of intersection of this curve and the straight line $B'N'$.

[10] The acceleration of the rate of growth of productive investment which takes place in the transition period cannot immediately follow the decision to raise the rate of productive accumulation, because of the time necessary for the construction of new plant. (Let us recall that the term 'investment' is used throughout the book to mean the volume of equipment delivered in a given year; the increase in the capital under construction is included in the 'increase in inventories'; see Ch. 1, sec. 2.) Thus, during an interval equal to the period of construction, no acceleration of either the growth of productive investment or of the national income takes place. However, the increase in capital under construction is accelerated while that in other inventories is slowed down, the total increase in inventories remaining unaltered. Indeed, according to our assumption that the total increase in inventories is proportional to the increase in the national income irrespective of the changes in its structure, this total increase in inventories will not be accelerated during the 'preliminary' period equal to the period of construction. It follows that during this period real wages are still rising at an undiminished rate. Their increase is stopped only when the accelerated growth of investment begins to take place; from this moment on, during period τ, real wages are kept at a constant level. Thus, the period of stability in real wages is not lengthened by taking into account the period of construction, only its beginning is postponed with regard to the moment of making the decision on raising the rate of growth.

In reality a shift from consumption to investment *does* lead to an accelerated rise in the increase in inventories, since the ratio of capital under construction to investment is higher than the corresponding ratio of consumption to its inventories, which, for the sake of simplicity, we did not take into account (see Ch. 2, sec. 4). Hence the situation with respect to real wages during the transition towards a higher rate of growth is less favourable in reality than that resulting from our simplifying assumption.

This should not, however, be construed as a recommendation to raise the rate of increase in productivity of labour α which is the result of technical progress with a constant capital–output ratio, and should, therefore, rather be treated as given (on this point see Chapter 7).

6. It is not out of place here to add a few observations on the nature of the 'government decision curve'. Its general features follow directly from our argument—namely that it is upward-sloping and that the lower is the rate of increase in productivity the higher are its ordinates corresponding to given levels of the rate of productive accumulation i. But is it possible to draw this curve in a precise fashion? Are its ordinates determined quantitatively similarly to those of the line CN which represents the relationship between the rate of growth r and the rate of productive accumulation i? The answer is definitely in the negative. Our curve serves only to illustrate the attitude of the government towards 'sacrificing the present for the future'. Even after the decision has been made we know only the point of intersection of the 'government decision curve' with the line $B'N'$, and the fact that at a higher rate of productive accumulation the balance of advantages and disadvantages (as expressed by formula (18)) would be negative, whilst at a lower rate it would be positive, which means that the curve is upward-sloping. In the former case its ordinate $\omega(i)/(1-i)$ is greater than $\Delta r/\Delta i = 1/k$ and thus

$$\omega(i)\,\frac{\Delta(i)}{1-i} > \Delta r$$

while in the latter case the reverse is true.

The main advantages of using the 'government decision curve' in our analysis will be seen in the discussion of cases where the relationship between the rate of growth r and the rate of productive accumulation i differs from that represented by the line BN (e.g. in the discussion of the problem of the effect of difficulties in balancing foreign trade or that of labour shortage). Indeed, the concept of the 'decision curve' will then enable us to show the effects of the changes in the relationship between r and i on the choice of the rate of growth of national income, given the attitude of the government towards 'sacrificing the present for the future'.[3]

5. Increasing the Rate of Growth of National Income under Conditions of a Limited Reserve of Labour

1. In the preceding chapter we assumed that there existed an unlimited supply of labour. We shall now consider the more realistic case of a limited reserve of labour. Thus if the rate of growth r exceeds the level $r_0 = \alpha + \beta$ this reserve will eventually be exhausted. The rate of growth of national income then returns, as described above, to the level r_0. Simultaneously the relative share of productive accumulation in the national income falls back to i_0, and the relative share of consumption to $1 - i_0$. The result of this process is that there is an additional increase in the national income to the extent corresponding to the excess of labour force over actual employment in the initial position. Since after the exhaustion of the reserve the relative share of consumption in the national income regains the level $1 - i_0$, it follows that the additional proportional increase in consumption (as compared with growth at a rate r_0) is the same as that of the national income.

We may illustrate this by the following example in which the discussion of the preceding chapter is also taken into account. Let us assume that the rate of growth of the labour force $\beta = 1.5\%$ p.a.; that of labour productivity $\alpha = 5.5\%$; and consequently, that of the national income in the initial situation $r_0 = 7\%$. Suppose that by taking advantage of a labour reserve the rate of growth of the national income is raised to the level $r = 8\%$. This, however, is done gradually, so as to maintain real wages at a constant level throughout the transition period. Suppose, furthermore, that in the initial period the relative share of productive accumulation in the national income, $i_0 = 26\%$. In order to raise r to the level of 8% p.a. it is necessary to increase this share to 29% (which corresponds to a capital–output ratio $k = 3$). From formula (20) we then obtain

$$\tau = \log \frac{0.74}{0.71} \cdot \frac{1}{0.055} = 0.8 \text{ years}$$

During this period the average annual rate of growth is about 7.5%. We assume that in the subsequent period of three years (in which the rate of growth is 8%), the reserve is exhausted. Thus over the whole period the national income is increased in the proportion $(1.075)^{0.8} . (1.08)^3 = 1.33$. If the rate of growth had been maintained at the initial level of $r = 7\%$, the national income would have been increased during the same period in the proportion $(1.07)^{3.8} = 1.28$. Hence, the absorption of excess labour permits an additional increase in the national income in the proportion $1.33/1.28 = 1.04$, i.e. by 4%. When the reserve has been absorbed and the rate of growth has returned to 7%, the relative share of productive accumulation in the national income falls back to 26% and that of consumption to 74% (i.e. to the proportions which would have existed if the rate of growth had been maintained all the time at the initial level); the additional proportionate increase in consumption as a result of this process is therefore equal to that in the national income, i.e. to 4%.

2. It follows that the acceleration of growth for only a limited period brings an unquestionable advantage; but can it be treated as equivalent to a permanent increase in the rate of growth? The only possible reason for answering in the affirmative would be that when returning to the initial lower rate of growth, we go back at the same time to the original proportion between productive accumulation and consumption. This argument may, however, be countered as follows: even if there are no physical obstacles to the unlimited continuation of a higher rate of growth, this does not exclude the possibility of returning at any time to the initial rate, with a corresponding reduction in the rate of productive accumulation. But if these obstacles do exist we *have* to return eventually to the initial position—unless we resort to mechanization which would require additional investment outlays (this will be discussed in more detail in a later chapter). Thus it will be seen that the case of raising the rate of growth from r_0 to r for a limited period must be treated as less favourable than raising this rate permanently.

We may thus say that an increase $r - r_0$ over a limited period could be expressed in terms of a permanent increase by means of a function $f(r - r_0)$, such that

$$f(r - r_0) < r - r_0$$

In addition the function has the following characteristics:

(i) When the value of r is r_0, the problem of exhausting the reserve does not arise, and hence $f(0) = 0$.

(ii) If $r - r_0$ is equal to a very small fraction, δ, the reserve will be exhausted after a very long period of time. This can be treated as equivalent to an unlimited period of time. Hence we have $f(\delta) = \delta$. Taking into account $f(0) = 0$ we obtain

$$\frac{f(\delta) - f(0)}{\delta} = 1$$

which means that the derivative of the function f is equal to 1 for $r = r_0$.

(iii) Finally, we may assume that f is an increasing function, but that as $r - r_0$ increases the difference between $r - r_0$ and $f(r - r_0)$ also increases. Indeed, the higher $r - r_0$, the sooner is the given reserve of labour exhausted, and the greater the divergence between $r - r_0$ and $f(r - r_0)$; consequently the derivative of the function f is positive and the same is true of the derivative of the expression $(r - r_0) - f(r - r_0)$. Thus we have

$$\frac{\Delta f(r - r_0)}{\Delta r} > 0$$

as well as

$$1 - \frac{\Delta f(r - r_0)}{\Delta r} > 0$$

and hence

$$0 < \frac{\Delta f(r - r_0)}{\Delta r} < 1$$

The inequality

$$\frac{\Delta f(r - r_0)}{\Delta r} < 1$$

is not satisfied, however, in the case of $r = r_0$, since, as shown in point (ii), we may disregard the exhaustion of the reserve when $r - r_0$ is very small, so that for $r = r_0$ the derivative is equal to 1. Thus we may finally write

$$\frac{\Delta f(r - r_0)}{\Delta r} = 1 \quad \text{for} \quad r = r_0$$

$$0 < \frac{\Delta f(r - r_0)}{\Delta r} < 1 \quad \text{for} \quad r > r_0$$

These results enable us now to consider the determination of the rate of growth where the reserve of labour is limited. In the case

of an *unlimited* reserve the balance of advantages and disadvantages of increasing the rate of growth by Δr was expressed as follows

$$\Delta r - \frac{\omega(i)}{1 - i} \Delta i$$

Since in the case of a limited reserve the 'equivalent' of r is $r_0 + f(r - r_0)$, it follows that instead of Δr we must introduce $\Delta f(r - r_0)$ in this expression. We thus obtain

$$\Delta f(r - r_0) - \frac{\omega(i)}{1 - i} \Delta i$$

or

$$\frac{\Delta f(r - r_0)}{\Delta r} \Delta r - \frac{\omega(i)}{1 - i} \Delta i$$

Hence the condition for determining the rate of growth of the national income will now be

$$\frac{\Delta r}{\Delta i} = \frac{\omega(i)}{(1 - i) \dfrac{\Delta f(r - r_0)}{\Delta r}}$$

whereas with unlimited labour it was

$$\frac{\Delta r}{\Delta i} = \frac{\omega(i)}{1 - i}$$

In Fig. 5 the decision curve $D'K'$ represents the case where there are unlimited reserves of labour, its ordinates being determined by the expression $\omega(i)/(1 - i)$. The decision curve $D'L'$ represents the case where there is a limited reserve of labour and its ordinates are determined by the expression

$$\frac{\omega(i)}{(1 - i) \dfrac{\Delta f(r - r_0)}{\Delta r}}$$

Since $\Delta f(r - r_0)/\Delta r$ is equal to one for $r = r_0$ and less than one (but positive) for $r > r_0$, the two curves have a common point of departure, but they diverge, $D'L'$ being situated above $D'K'$.

As a result, the point of intersection of the 'decision curve' and the horizontal line, $B'N'$, is shifted to the left in the case of a limited reserve of labour. Thus in such a case the relative share

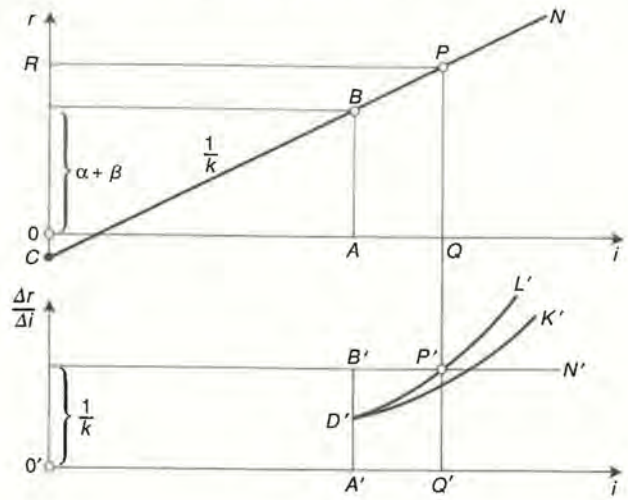

FIG. 5

of productive accumulation in the national income i and the rate of growth r tend to be fixed at their respective lower levels than in the case of unlimited supplies of labour. This may be interpreted as the effect of the labour-supply barrier on the rate of growth; a limited reserve of labour only makes it possible to shift this barrier, not to eliminate it altogether.

6. Balancing Foreign Trade as a Factor Limiting the Rate of Growth

1. In the preceding chapters we discussed the problem of the choice of the rate of growth of the national income given a reserve of labour. The main brake on the rate of growth in such a situation is the 'cost' in terms of the adverse effect upon the level of consumption in the short run. This is not, however, the only factor apart from shortage of labour which limits the rate of growth. Another obstacle to the acceleration of growth is the difficulty in balancing foreign trade which—as will be seen below—is more of a problem, the higher the rate of growth.

It should be recalled, first of all, that according to our assumptions the economy neither grants nor receives foreign credits so that its foreign trade must be balanced. Thus any increase in imports must be covered by an equal increase in exports.

In the course of economic development the demand for imports is increasing and, consequently, so are the exports required to cover the imports. It follows that the higher the rate of growth of national income r, the more rapidly must exports increase and the more difficult it is to sell them, in view of the limited foreign demand for the products of a given country. A higher rate of growth r will thus require *ceteris paribus* a greater effort to promote exports or to restrict imports. Efforts to promote exports will be associated with reductions in export prices for certain goods in certain markets, with a shift to less profitable markets, and with the inclusion of less profitable items in the list of exportable goods. The effort to curtail imports consists, of course, of substituting home-made goods for imported commodities.

In all these cases the increase in the national income will tend to decline in relation to the outlays of capital and labour involved. Indeed, if foreign trade is balanced, the national income is—according to our definitions—equal to the sum of productive accumulation and consumption (in the broad sense) at constant prices. But in the circumstances outlined above the outlays necessary to obtain certain commodities will increase—because the imports of these goods will either be paid for by a larger volume of exports, or by exports of a different structure requiring higher outlays, or because the outlays necessary to produce at home the commodities formerly imported will be higher than those for producing the exports by means of which they were procured.

As a result, efforts to maintain the rate of growth at a higher level will reduce the increment in the national income corresponding to given outlays and this reduction is greater the higher the level attained.

2. The phenomena described above emerge against the background of difficulties encountered in placing the exports which have to increase along with the rapidly growing national income in order to cover the cost of imports. This, however, is not the only source of difficulties in balancing foreign trade at a high rate of growth of national income. When this rate exceeds a certain level, the output of certain industries in the national economy—particularly those producing raw materials—lags behind the demand for those products owing to certain technological and organizational factors of which more will be said below. Hence, either the demand for imports of these products increases, or their export potential declines. The outcome is a gap in foreign trade which calls for appropriate efforts in promoting exports, or substituting home production for imports—again tending to reduce the increment in the national income corresponding to given outlays.

The technological and organizational factors limiting the rate of growth in particular industries are of varied character. The simplest case is that of limited natural resources (mineral deposits, woods, fisheries).

Moreover, experience in implementing plans for economic development shows that insurmountable difficulties arise whenever the expansion of a particular industry exceeds a certain rate, even if finance is adequate. An important role is played here by the long periods of construction of some projects, e.g. of coalmines.

Indeed, given the rate of expansion in a particular industry, the volume of 'projects under construction' is proportional to the length of the period of construction. If this period is long and the rate of expansion is high, the number of different 'building sites' becomes so great that the available technical and organizational staff is not adequate to run them efficiently. As a result, the period of construction becomes longer still, and the excessive number of 'building sites' leads to 'freezing' of capital rather than to a more rapid expansion of the industry concerned. It must be borne in mind that the technical and organizational staff required for the construction of plant has to be very highly skilled—much more so than the staff who will run the plant in the future.

Limited natural resources and the long period of construction are not, however, the only technical and organizational factors hampering the rate of expansion in individual sectors of the economy. One should also take into account the difficulty of recruiting workers to particular occupations (e.g. coalmining), and the time necessary to master new technological processes.

A specific case is that of agriculture where a certain element of spontaneity always remains in the development of production. In particular, the introduction of higher technology takes rather a long time here.

3. Let us now return to the influence of difficulties in balancing foreign trade on the rate of growth of the national income.

We again adopt as our initial situation the growth at a rate $r_0 = \alpha + \beta$, where α denotes the rate of increase in labour productivity resulting from technical progress, and β is the natural rate of growth of the labour force. In the case of an unlimited supply of labour the rate of growth of national income may be increased and for this purpose the rate of productive accumulation is raised from i_0 to i. If no difficulties in balancing foreign trade were caused by this acceleration, the rate of growth would rise from r_0 to a level ρ represented as a function of i by the ordinate of the line BN (see Fig. 6). The annual increment in national income Y would then be ρY; but it follows from the above that as a result of difficulties in balancing foreign trade, this increment will amount to $rY < \rho Y$. Thus the rate of growth r will be lower than ρ. In addition the higher i and ρ, the greater are the difficulties with foreign trade, and the lower the ratio $(r - r_0)/(\rho - r_0)$. In Fig. 6, as was noted above, the straight line BN represents the relationship between ρ and i, while the relationship between r and i is now represented by the curve BS. It will be seen that on the diagram this curve levels off at the point S. This signifies that owing to the difficulties in foreign trade the rate r cannot exceed a certain level. Such is, indeed, the case in reality. At a certain rate of growth all efforts to equilibrate imports and exports cease to yield positive results. A further reduction in export prices does not serve any useful purpose, because it increases the volume of exports, but not its value (in foreign exchange)—the increase in volume being compensated by the decrease in price. Both less favourable markets and less profitable goods have been made use of to the limit. The same is true of feasible investment in import-substitution. Thus foreign-trade difficulties resulting from limited

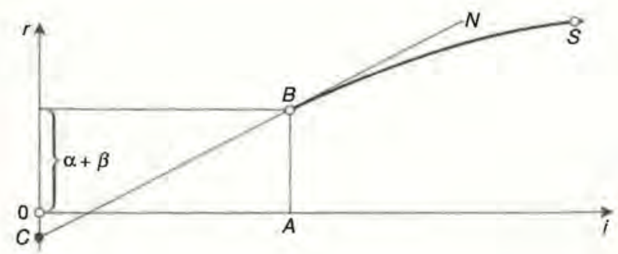

FIG. 6

foreign markets, along with the technological and organizational factors which hamper the development of particular industries, set a ceiling for the rate of growth.

4. As indicated above, the difficulties experienced in foreign trade lead to an increase in the outlays of both capital and labour per unit increment in national income. As far as a higher labour outlay is concerned, this amounts to a relative reduction of productivity within the increment of national income (i.e. marginal productivity). This results in the rate of increase of average productivity falling short of the rate α produced by technical progress.[11]

As a result, the transition period τ, during which the rate of productive accumulation is raised from i_0 to i by keeping real wages stable despite increasing productivity of labour, is lengthened.

5. In Fig. 7 the determination of the rate of growth is presented in a similar way to that of Fig. 4. Since the slope of the tangent at any point of the curve BS is lower than that of the straight line BN, the curve $B''S'$ representing $\Delta r/\Delta i$ is situated below the line $B'N'$ which corresponds to the slope $1/k$. Moreover, since the slope of the curve BS diminishes as i rises, reaching the zero at point S, the curve $B''S'$ is downward-sloping and intersects the i-axis at the point S', vertically below point S.

The curve $D'J'$ is a 'government decision curve' conceptually identical to the curve $D'K'$ in Fig. 4. However, the latter needs some modification as a result of difficulties in balancing foreign trade. As pointed out above, the transition period τ, during which the rate of productive accumulation is raised from i_0 to i with real wages remaining stable, is lengthened as a result of difficulties in balancing foreign trade; as a result the coefficient $\omega(i)$ is increased in the expression representing the balance of advantages and disadvantages of raising the rate of growth, i.e.

[11] If it is assumed that the marginal productivity of labour in the sense employed here remains constant over time, provided the effects of technical progress are eliminated, and if, moreover, it is assumed as above that this productivity is lower than average productivity in the economy in the initial period calculated on the basis of the new technique in that period, then it is clear that the rate of increase in average productivity differs less and less from α, approaching this level asymptotically.

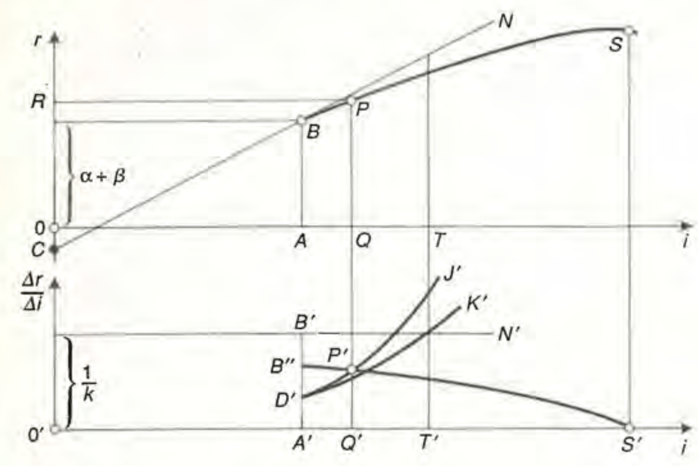

FIG. 7

$$\Delta r - \frac{\omega(i)}{1 - i}\,\Delta i$$

This reflects the fact that the conditions for raising the relative share of accumulation i in the national income deteriorate and thus the 'cost' of increasing i by Δi increases. As a result the appropriate 'decision curve' $D'J'$ is above the curve $D'K'$ which does not allow for the effect of difficulties in balancing foreign trade upon attempts to raise the rate of growth.

As in Fig. 4, the rate of productive accumulation and the rate of growth of the national income are determined by the point of intersection P' of the curves $D'J'$ and $D'K'$, which is projected on to the curve BS. If difficulties in foreign trade are disregarded, i and r are determined by the point of intersection of the horizontal line $B'N'$ and the curve $D'K'$, which is projected on to the straight line BN. It will be seen that difficulties in balancing foreign trade lead to the adoption of a much lower rate of growth; firstly, the rate of productive accumulation is fixed by the government at a level $0Q$ which is lower than $0T$; and secondly, the point P corresponding to it lies on the curve BS which is situated below the straight line BN.

6. It is quite possible that B'', the point of departure of the curve $B''S'$, may be identical with D', the beginning of the decision

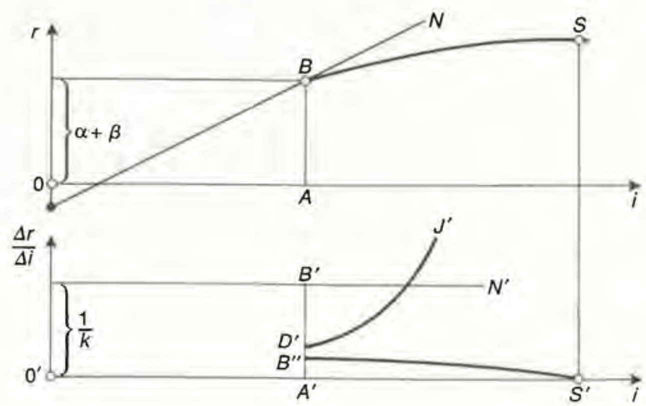

FIG. 8

curve. This would, of course, mean that the government should not raise the rate of growth above the level $r_0 = \alpha + \beta$, i.e. that determined by the rate of increase in productivity of labour resulting from technical progress and natural growth of the labour force.

It is also conceivable that point B'' will lie below D' (see Fig. 8). Would this mean that the government would slow down the rate of growth below the level r_0?

Since it may be assumed that the government is unwilling to accept growing unemployment, it can be assumed that the 'decision curve' drops abruptly to the left of point D', so that the curves $B''S'$ and $D'J'$ intersect practically at point B'' and thus the rate of growth is equal to r_0.

It is obvious that the situation considered here, where it is decided not to raise the rate of growth above $r_0 = \alpha + \beta$, may also arise without difficulties in balancing foreign trade. However, these difficulties make it much more likely, since they contribute to the curve $B''S'$ being situated below the straight line $B'N'$.

7. Let us now introduce the problem of a limited reserve of labour. The curve BS, and hence the curve $B''S'$, will not be affected. The fact that the reserve of labour is limited will be reflected—as in our argument in the preceding chapter—in the position of the 'decision curve' $D'I'$ (see Fig. 9) which has a common point of departure with the 'decision curve' for an unlimited reserve of labour $D'J'$, but for values of i higher than

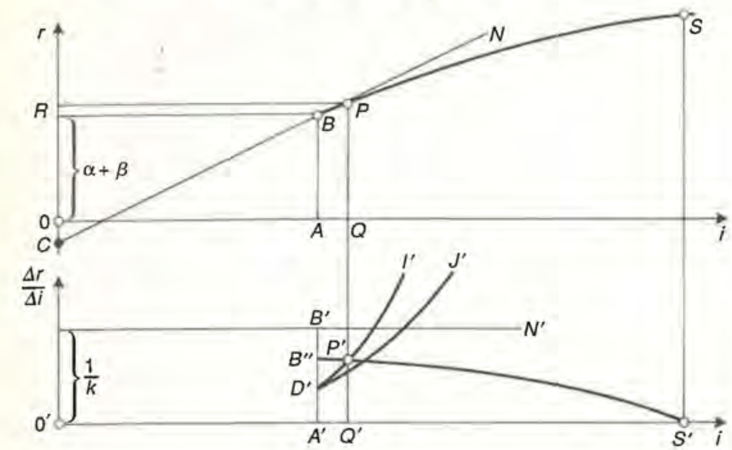

FIG. 9

i_0 is situated above the latter. Foreign trade difficulties tend to shift the curve even further, since they result in a more rapid absorption of the labour reserve owing to the reduction in the rate of increase of the productivity of labour (see section 4 of the present chapter).

The rate of growth of national income is given by the point P' at the intersection of the curves $B''S'$ and $D'I'$. It is, of course, lower than the rate of growth with an unlimited labour reserve, which is determined by the point of intersection of the curves $B''S'$ and $D'J'$.

8. It should be noted that in long-run plans the estimation of the impact of foreign trade on the increment in national income which corresponds to given outlays is always very hypothetical in character. Thus uncertainty will lead to the adoption of rather 'conservative' estimates and thus ultimately to the choice of a relatively low rate of growth. Therefore the elimination of this uncertainty by long-term trade agreements—such as are concluded within the socialist camp—favours a higher rate of growth of national income. Obviously, such agreements do not solve the problem of placing the increased exports. When the other party is not willing to accept larger quantities of certain commodities it is, for instance, necessary to offer less profitable items, and sometimes it may even be entirely impossible to increase exports beyond a certain level. But the results of the agreements are facts, rather than tentative forecasts; thus they need not be treated as cautiously as expectations concerning the future prospects of foreign trade.

It follows that, by predetermining the major part of the future foreign trade of the socialist countries, long-term trade agreements between them contribute to the acceleration of their development.

9. Before concluding this chapter, it is useful to consider whether the problems discussed in it would disappear in the closed economy of a self-sufficient country. Such would indeed be the case, but only on condition that there were no bottlenecks to economic development—such as those discussed in section 2. If, on the other hand, with high rates of growth of national income, the output of particular industries lagged behind demand due to the influence of technological and organizational factors, then the factors hampering development would be further accentuated in the absence of foreign trade. Indeed, there would be then no possibility of filling the gaps by imports acquired in exchange for exports of those goods whose production can expand without encountering technological and organizational barriers. The only possible approach to the long-run bottlenecks would be to produce substitutes for the scarce goods (corresponding to the substitution of home production for imports discussed in preceding sections) which in many cases would be much less favourable than the expansion of exports.

7. Acceleration of the Increase in Labour Productivity by Raising the Capital–Output Ratio or by Shortening the Life-Span of Equipment

1. In Chapters 4 and 5 we discussed the case in which the existence of a reserve of labour made it possible to increase the rate of growth, with the parameters m, k, a, and u remaining constant. We shall now assume that in the initial situation we have no underemployment. Since the rate of increase of the labour force is treated as given, the acceleration of growth in such a case may be achieved only by raising the rate of increase of labour productivity. This may be done by changing one of the above parameters as follows:

(i) increasing the capital–output ratio m and thus also the parameter k;[12]
(ii) shortening the life-span of equipment, which leads to an increase in the parameter of depreciation a.

We shall begin by considering the effects of increasing the capital–output ratio. In order to prepare the ground for this discussion we have first briefly to examine the problem of the 'production curve' and that of technical progress.

2. Let us consider the problem of different ways of producing an increment in the national income using new investment. Let us assume that this increment has a given structure—in other words, it consists of given quantities of various final products (i.e. products that do not go through further manufacturing processes within the period considered). Usually, each of these products, or rather group of similar products, can be produced by several different methods of production based on technical knowledge existing at a given time. It follows that to produce a given increment in the national income there exists an immense number of variants, each of them consisting of a combination of variants for producing particular types of commodity. Let us denote by s the number of types of commodity, by N_1 the number of variants for the first group of products, by N_2 the number of those for the second type . . . and by N_s the number of those for the sth type. The total number of combinations for all types of commodity will then be $N_1 \times N_2 \times N_3 \times \ldots \times N_s$ which for a large s will be a very large number, even if we only have two alternatives for each type of commodity.

When production is considered in all its stages, each variant is characterized by specific outlays of investment and labour. Out of all the possible variants for producing a given increment in the national income, we may discard those which are 'worse' than some others, with respect to both investment and labour inputs, i.e. which require higher outlays of both factors (or an equal outlay of one and a higher outlay of the other), i.e. variants which are absolutely inferior. We shall then be left with only those variants where greater investment is associated with less labour

[12] Let us recall that m is the capital–output ratio for fixed capital only, and k is the ratio for fixed capital together with inventories.

and vice versa. These may be represented diagrammatically as in Fig. 10.

As the abscissa we plot investment outlay and as the ordinate the labour outlay required to produce a given increment in the national income. Each variant will then be represented by a different point on the curve. It is clear that the set of admissible variants may be represented by a downward-sloping curve such as MN. Indeed, to any given investment outlay $0A$ there corresponds only one labour outlay AB. If there were two possible corresponding values of the labour outlay, then the alternative involving the higher outlay of labour would be less favourable and would be rejected. The curve is downwards sloping, since—as was pointed out—a higher investment outlay is associated with a lower outlay of labour. The curve MN is called the 'production curve'.[13]

If this curve refers to a unit increment in the national income, the investment outlay is equal to the capital–output ratio m, the latter being simply the investment outlay per unit increment in national income (see Chapter 2, section 1). Let us denote the labour outlay per unit increment in national income by λ. Accordingly, we shall plot m on the abscissa and λ on the ordinate (see Fig. 11).

The curve of production at time t is—as mentioned above—based on the body of technical knowledge existing at that time as a result of previous technical progress. But technical progress does not stop at time t, and is reflected in a downward shift of the curve of production which takes the successive positions $t+1$, $t+2$, etc. Thus, owing to technical progress, the λ corresponding to a given m is subject to a steady decline. We shall call technical progress 'uniform' if the labour outlay λ corresponding to a given m decreases at a constant rate. This means that with a constant level of the capital–output ratio m, the productivity of labour in new plant increases at a constant rate. It is this case that was considered in the previous chapters.

[13] It may seem doubtful whether the central authorities are able to check on the multitude of variants in order to eliminate those which are absolutely inferior to some alternative variant. It is possible to show, however, that if in particular branches of the economy the choice between alternative variants is based on the evaluation of the efficiency of investment, these variants are automatically eliminated (see Appendix from which it also follows that the curve of production is concave).

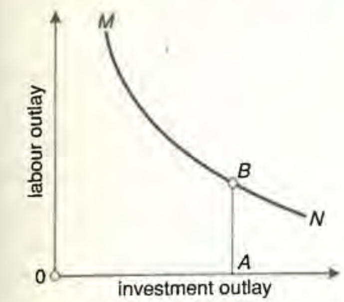

FIG. 10

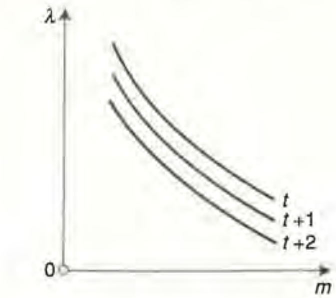

FIG. 11

From the fact that to a given m there corresponds a fixed rate of decrease in the unit labour outlay λ, and thus also a definite rate of increase of productivity, it does not necessarily follow that this rate is the same for all values of the capital–output ratio m. Such a case is represented in Fig. 12*a*, and is possible but not inevitable. It is conceivable that the rate of decrease of λ (or the rate of increase in productivity) is greater the higher the value of m (Fig. 12*b*), or vice versa (Fig. 12*c*).

In case (a) a shift towards higher capital intensity (from m_0 to m_1) causes a once-for-all increase in productivity in new plant, but does not raise the *rate* of increase of this productivity; we describe such technical progress as 'neutral'. In case (b) the rate of increase in productivity is greater the greater capital intensity; we describe this type of technical progress as 'encouraging capital intensity'. Finally, in case (c) a rise in capital intensity, while bringing about

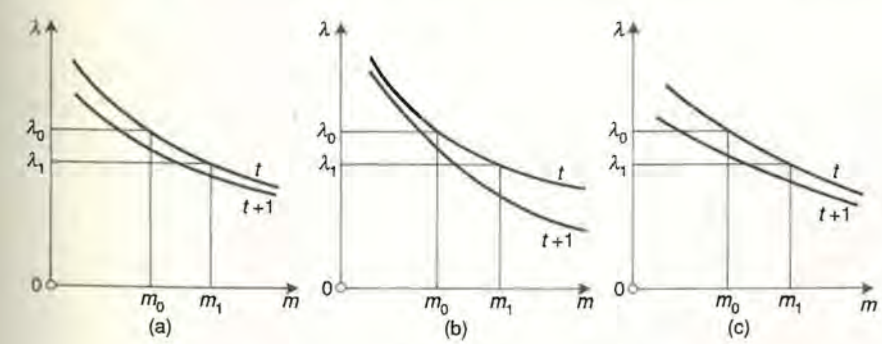

FIG. 12

an increase in the level of productivity in new plant, leads at the same time to a decline in the rate of increase in labour productivity. Accordingly, this type of technical progress will be described as 'discouraging capital intensity'.

We may give the following example of technical progress 'encouraging capital intensity'. Suppose there are two variants for each group of products: A of a lower, and B of a higher capital intensity. Suppose, moreover, that in newly invented variants the capital intensity is in all cases equal to that of B. The level of productivity is, of course, higher in those newly invented variants, so that all former variants B for individual groups of products must be discarded and replaced by newly discovered solutions. But there is no *a priori* reason for discarding the variants A, because their capital intensity is lower than that of the new solutions.

Let us consider the repercussions of this type of technical progress if m is given. At time t there corresponds to a given m a definite combination of variants for individual groups of products: in some cases it is the variant A and in others B. At time $t+1$, according to what we said above, in all cases where new inventions have occurred, the variants B will have been replaced by newly invented solutions. But, if m is to stay constant, the variants A must not be touched since, should they be replaced by newly invented variants of capital intensity B, m would have to change. It is now easy to see that technical progress is here 'encouraging capital intensity'. Indeed, the higher the value of m, the greater the weight of more capital-intensive variants B, and thus the greater the scope for replacement by newly discovered solutions, and the greater the increase in productivity.

For technical progress 'discouraging capital intensity', the following situation may be given as an example. Let us suppose that the newly invented variants have a capital intensity equal to that of the variants A and that their level of productivity, though increasing, remains below that of the variants B in the years considered. It follows that whenever a new invention occurs the variants A must be discarded and replaced by the newly discovered techniques. But there is no *a priori* reason for the variants B to be discarded, since by assumption they have a higher productivity than the new inventions. By time $t+1$, therefore, the combination of variants for individual products which corresponded to a given m at time t has been changed by replacing variants A by newly discovered techniques, leaving variants B unaltered; if variants B were to be replaced by new techniques of the capital intensity of A, m would have to change. The higher the value of m the smaller the weight of less capital-intensive variants; consequently, there is less scope for replacement by newly discovered techniques and the increase in productivity is smaller. Thus this is a case of technical progress 'discouraging capital intensity'.

3. The prevailing type of technical progress by no means dictates the path economic development takes in practice. For example, if technical progress is 'encouraging capital intensity', this does not mean that the coefficient m is bound to increase. It follows from Fig. 12*b* that in such a case even when m remains constant we shall obtain a regular increase in productivity in the new plant. By contrast, in the case of neutral technical progress there is no necessity for m to remain constant; we may raise it gradually and in this way achieve a more rapid increase in productivity by moving to the right along the curve of production as it shifts downwards. Obviously, such an operation is much more attractive when technical progress is 'encouraging capital intensity' because then we gain also the advantage of a higher rate of increase in productivity for higher capital–output ratios.[4]

In what follows we shall concentrate on a detailed discussion of the effects of a once-for-all increase in the capital–output ratio, this being a more elementary case than that of its continuous increase. Our analysis also sheds some light on the latter more complicated case which will, however, be treated only in a general way.

4. We shall now examine the repercussions of raising the capital–output ratio on the increase in the average productivity of labour. Let us first take the case of neutral technical progress. If at time t the capital–output ratio is raised from m_0 to m_1, this involves a rise in productivity which is proportional to the reciprocal of the relative decline in the quantity of labour required, i.e. a rise in the proportion λ_0/λ_1 (see Fig. 12*a*). This obviously applies to labour productivity in new plant. As far as aggregate capital equipment is concerned, adjustment to a higher capital–output ratio is carried out gradually. Every year some equipment

based on the 'old' technology (corresponding to m_0) is scrapped, and some new equipment based on the 'new' technology (corresponding to m_1) is added. The longer this process goes on, the greater becomes the 'recast' portion of total capital equipment. Finally, after a period n, equal to the life-span of equipment, i.e. after the complete elimination of equipment characterized by the 'old' technique, all the fixed capital has a capital–output ratio m_1 and labour productivity is correspondingly higher. Thus the rise in productivity which is realized immediately for new plant takes a period of n years to extend to aggregate fixed capital.

During this period average productivity increases at a higher rate than that resulting from technical progress. (The latter rate remains unchanged after the capital–output ratio has been raised from m_0 to m_1, since we are here discussing neutral technical progress.) The labour released from scrapping old plant, and the newly accruing labour force, produces a higher output than if m had not been increased. Thus the increment in the national income due to new investment is raised while the loss of national income resulting from discarding old equipment remains unchanged. The difference between the rate of increase of productivity and α is greatest at the beginning of the period of 'recasting'; as the higher capital–output ratio and higher productivity pervade the stock of capital equipment more and more, new investment contributes proportionately less to the increase of both the overall capital–output ratio and overall productivity, because the difference between new investment and the stock of capital equipment is less and less pronounced. Eventually, when all fixed capital is 'recast' the process of raising the rate of increase of labour productivity comes to an end. Indeed, at this point the two following conditions hold:

(i) the whole stock of equipment is characterized by the same capital intensity and productivity as new investment;
(ii) the loss of national income due to scrapping of obsolete equipment is also increased accordingly.

Thus the rate of increase of productivity goes back to its normal level—resulting solely from technical progress—and the rate of growth of the national income to the level $\alpha + \beta$. The changes in the rate of growth of national income and in productivity in the period of 'recasting' are represented in Fig. 13, where δ denotes

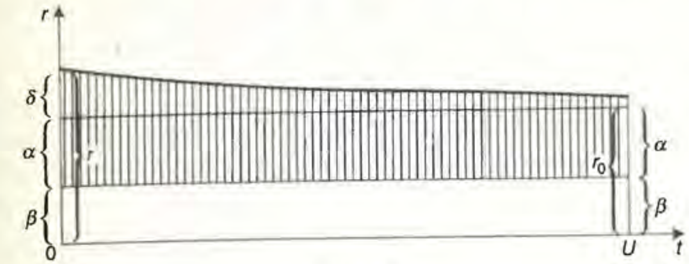

FIG. 13

the increment in the rate of increase of productivity at the beginning of that period. The rate of increase of productivity (shaded area) declines over the period of 'recasting' from $\alpha + \delta$ to α, and the rate of growth of the national income from $\alpha + \delta + \beta$ to $\alpha + \beta$. The abrupt drop in these rates at the end of 'recasting' reflects the fact that the equipment scrapped begins also to be endowed with higher productivity of labour.

This process will follow a different course in the case of technical progress 'encouraging capital intensity'. In this case, the adoption of a higher capital–output ratio results not only in a once-for-all increase in productivity in the new plant, but also in an increased rate of growth of this productivity. Thus when the process of 'recasting' to give the stock of capital equipment a higher capital intensity comes to an end after n years, the rate of growth of productivity does not go back to the initial level α, but is stabilized at a higher level α'. During the period of 'recasting' the slackening of the pace at which fixed capital is adjusted to a higher capital intensity—and consequently to a higher labour productivity—is, at least in part, compensated by the increasing influence of the rise in productivity in the new plant at a rate α', greater than α.

5. Let us consider now the problem of increasing productivity by shortening the life-span of equipment. The shorter this life-span, the higher is the average productivity of labour, because this average is then nearer to the level of productivity in new plant. In other words, the lower the average age of the stock of capital equipment, the higher the average productivity of labour.

Suppose, now, that the life-span of equipment is initially n. The 'rejuvenation' of fixed capital by a gradual reduction in the life-span of equipment to n' will lead, according to the above, to an increase in the average productivity of labour. But after this increase has been effected the rate of growth of productivity will fall back to the initial level α, and that of the national income to $\alpha + \beta$. This is similar to what happened in the case of 'recasting' fixed capital in order to raise its intensity with neutral technical progress; there too, after aggregate fixed capital has been endowed with a higher capital intensity the rate of increase in productivity falls back to the initial level.

The 'rejuvenation' of fixed capital is assumed to be carried out by increasing the scrapping of productive capacity in the proportion a/a_0 where the parameter of depreciation a_0 corresponds to the life-span n and to the constant rate of growth $r_0 = \alpha + \beta$, while the parameter a corresponds to a shorter life-span n' and the same rate of growth.

It may be shown that after n' years the equipment existing at the outset of the 'rejuvenation' will have been scrapped, and thus the process of 'rejuvenation' will then be complete.[14] Moreover, the actual parameter of depreciation is obviously nearly equal to a in the first year of the 'rejuvenation' process, since the national income still differs little from what it would be without 'rejuvenation', while the loss of output due to the scrapping of old capacities is increased in the proportion a/a_0. Finally it may be shown rigorously that after the termination of the 'rejuvenation'

[14] Let us denote the productive capacities which in the initial position correspond to investment in the previous n years, i.e. to $I_1, I_2, \ldots, I_n$, by $P_1, P_2, \ldots, P_n$. P is not proportional to I because of the factor u (see Ch. 3, sect. 2). Aggregate productive capacity existing at that time is therefore equal to $P_1 + P_2 + \ldots + P_n$. Thus in the absence of 'rejuvenation' the capacities scrapped in the subsequent n years would be $P_1, P_2, \ldots$, etc. Multiplying these quantities by the factor a/a_0 we obtain $P_1(a/a_0), P_2(a/a_0), \ldots$, etc. for the capacities existing in the initial position scrapped in successive years. But from Ch. 3, sect. 2 it follows that for uniform growth

$$\frac{a}{a_0} = \frac{P_1 + P_2 + \ldots + P_n}{P_1 + P_2 + \ldots + P_{n'}}$$

Thus in the course of n' years the aggregate productive capacity existing in the initial position will have been scrapped

$$(P_1 + P_2 + \ldots + P_{n'}) \frac{P_1 + P_2 + \ldots + P_n}{P_1 + P_2 + \ldots + P_{n'}} = P_1 + P_2 + \ldots + P_n.$$

process the system returns to uniform growth at a rate r_0 with a parameter of depreciation a.[15]

[15] Let us first suppose that there is no attempt at 'rejuvenation', and the process of uniform growth at a rate r_0 continues for n years. We denote the capacity at the end of the period created by new investment in successive years of that period by $Q_1, Q_2, \ldots, Q_n$. It is clear that $Q_1 = P_1(1 + r_0)^n$; $Q_2 = P_2(1 + r_0)^n, \ldots$ etc. where $P_1, P_2, \ldots$ etc. have the same meaning as in n. 14. Now the capacity Q_1 may be divided into two parts: that manned by the labour released by the scrapping of the capacity P_1, and, secondly, that manned by new additions to the labour force (including that resulting from the discrepancy between the rate of increase in productivity in existing plant w and the rate of improvement in the utilization of equipment u – cf. n. 7 above). The first part will be $P_1(1 + \alpha)^n$ and the second

$$Q_1 - P_1(1 + \alpha)^n; \quad \text{or} \quad \frac{Q_1}{(1 + r_0)^n}(1 + \alpha)^n = \frac{Q_1}{(1 + \beta)^n}, \quad \text{and} \quad Q_1 - \frac{Q_1}{(1 + \beta)^n}$$

respectively. Let us now increase the scrapping of old productive capacity in the proportion a/a_0. As a result the labour released by scrapping will be increased in this proportion. The productive capacity corresponding to Q_1 will be higher now because the second component remains unchanged but the first becomes

$$\frac{Q_1}{(1 + \beta)^n} \frac{a}{a_0}$$

Thus total capacity will be

$$\frac{Q_1}{(1 + \beta)^n} \frac{a}{a_0} + \left[Q_1 - \frac{Q_1}{(1 + \beta)^n}\right] = Q_1 \left[\left(\frac{a}{a_0} - 1\right) \frac{1}{(1 + \beta)^n} + 1\right]$$

This, however, is the productive capacity as it would exist after n years. In fact, the process of 'rejuvenation' is terminated according to the preceding footnote after n' years. Thus the capacity as it will exist at the time of termination of the process will be reduced in the proportion

$$\frac{1}{(1 + u)^{n - n'}}.$$

Consequently it will amount to

$$Q_1' = Q_1 \frac{\left(\frac{a}{a_0} - 1\right) \frac{1}{(1 + \beta)^n} + 1}{(1 + u)^{n - n'}}$$

A similar expression will be obtained for the capacities $Q_2', Q_3', \ldots, Q_{n'}'$. It follows that in the process of 'rejuvenation' all the productive capacities $Q_1, Q_2, \ldots, Q_{n'}$ are raised in the same proportion while the capacities

$$P_1(a/a_0), \quad P_2(a/a_0), \ldots, \quad P_{n'}'(a/a_0)$$

are scrapped instead of $P_1, P_2, \ldots, P_{n'}$. From this it is easy to conclude that after the period of 'rejuvenation' the system is poised for uniform growth at a rate r_0, the life-span of equipment being n' and the parameter of depreciation a.

8. Increasing the Rate of Growth of National Income under Conditions of Full Employment by Raising the Capital–Output Ratio

1. Let us assume that labour productivity is increased by raising the capital–output ratio, technical progress being neutral. As a result of increasing the capital–output ratio from its initial level m_0 to the level m, labour productivity in new plant is raised $(1+p)$ times. As was pointed out above, for aggregate capital equipment this process of 'recasting' takes n years, where n is the life-span of equipment. During this period the average productivity of labour increases more rapidly than in the initial situation, i.e. at a rate higher than α. This extra growth, however, slackens gradually and comes to an end when the process of 'recasting' fixed capital is complete. The rate of increase in employment β being constant, this amounts to a faster growth of national income for a period of n years. The rate of growth, which was $r_0 = \alpha + \beta$ in the initial situation, is raised to the level $r = \alpha + \delta + \beta$ at the beginning of the period and declines back to $r_0 = \alpha + \beta$ at its end. Thus it is obvious that the average rate of growth of the national income over the period of 'recasting' is higher than r_0, but lower than r. It amounts to

$$r_{av} = (1 + r_0)\sqrt[n]{(1+p)} - 1 \tag{21}$$

For at the end of n years the national income will be

$$(1 + r_0)^n (1 + p)$$

times its level in the initial year, since the productivity of labour is increased $(1 + p)$ times by the increase in capital intensity.[16] Thus on the average, the national income will increase in the proportion $(1 + r_0)\sqrt[n]{(1+p)}$ each year, and its average annual rate of growth will be $(1 + r_0)\sqrt[n]{(1+p)} - 1$.

[16] This can be proved rigorously as follows: the labour released by scrapping old plant, and by new accruals to the labour force (including that resulting from the discrepancy between the rate of increase in productivity in new plant, w, and the rate of improvement in the utilization of equipment, u (cf. n. 7 above)) is the same as it would be if m remained unchanged. Hence now investment generates an output which is $(1 + p)$ times higher than in that case. Thus the aggregate stock of capital after the completion of 'recasting' produces an output which is increased in this proportion. It also follows that after the completion of 'recasting' the system is poised for uniform growth at a rate $\alpha + \beta$.

We shall now present diagrammatically the process of accelerating the growth of national income. For this purpose we shall use a diagram similar to that in Fig. 2. Again we plot the rate of productive accumulation i on the abscissa, and the rate of growth r of the national income on the ordinate. In the initial situation the rate of growth of the national income r_0 is equal to $\alpha + \beta$, while the capital–output ratio is k_0. The relationship between r and the rate of productive accumulation is expressed by the equation

$$r = \frac{1}{k_0} i - \frac{m_0}{k_0}(a - u) \tag{7'}$$

This equation is represented in Fig. 14 by the line BN, the slope of which is $1/k_0$. The rate of productive accumulation in the initial situation is i_0, equal to $0A$.

We now raise the capital–output ratio from its initial level m_0 to the level m. This results in a rise in the productivity of labour in new plant in the proportion $1 + p$. The capital–output ratio k_0 (which relates productive investment plus the increase in inventories to the increment in national income) is raised to the level k. We have

$$k - m = k_0 - m_0 = \mu \tag{22}$$

where μ is the coefficient showing the relation between the increase in inventories and that in national income (see Chapter 2, section 4). The relation between r and i in the new situation is expressed by the formula

$$r = \frac{1}{k} i - \frac{m}{k}(a - u) \tag{7}$$

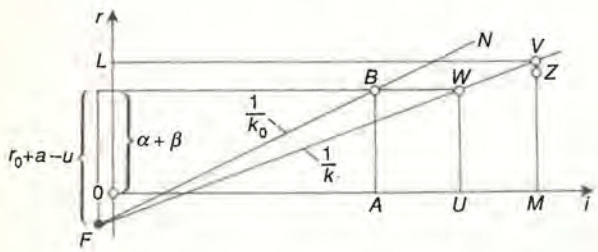

FIG. 14

represented in the diagram by the straight line WV, the slope of which is $1/k$. We now determine F, the point of intersection of the straight lines BN and WV, by finding the solutions for r and i from equations (7′) and (7) while taking into account equation (22). We obtain $-\mu(a-u)$ for the abscissa of point F and $-(a-u)$ for the ordinate. It follows that the position of point F does not depend on the magnitude of the capital–output ratio, so that when k changes the straight line representing the relationship between r and i rotates around point F.

As a result of raising the productivity of labour in new plant in the proportion $1+p$, the rate of growth of the national income in the first year of 'recasting' is increased to the level r represented by $0L$ in Fig. 14. This is accompanied by a rise in the rate of productive accumulation to the level i, equal to $0M$. In the course of 'recasting' fixed capital, the point corresponding to the rate of growth and the rate of productive accumulation moves from V to W.[17] The point W shows the situation at the end of the period of 'recasting'. It is characterized by the initial rate of growth r_0 and the rate of accumulation i_n (equal to $0U$) which is higher than the rate of accumulation in the initial position, i_0 (equal to $0A$) owing to the higher capital–output ratio. The rate of growth falls back to its initial level, but the rise in the capital–output ratio is irreversible and burdens the economy 'for good' with a higher rate of productive accumulation.

This obviously affects the level of consumption at the end of the period of 'recasting' and, consequently, the average rate of growth of consumption during this period. As was shown above at the end of the period of n years the national income is

[17] It should be noted that the presentation of the process of 'recasting' by means of Fig. 14 is not quite accurate. The point F is not in fact fully immobile in the course of this process, since the parameter of depreciation does not remain unaltered during the 'recasting'. This would be the case if the rate of growth of the national income amounted to r_0 all the time. However, the whole aim of the process of 'recasting' is just to raise this rate. As a result the same volume of scrapping of old equipment (corresponding to its life-span n) will be associated with a higher level of national income than that which would obtain if the rate of growth r_0 had been maintained. Thus in the course of 'recasting' the parameter of depreciation a will be falling, and the point F will be moving upwards and to the right because its abscissa is $-\mu(a-u)$ and its ordinate $-(a-u)$. As a result, in the period of 'recasting' the straight line FV will be shifting upwards, but without changing its slope. (We assume here that $\mu < 1$ which is quite realistic.) After this period there will be a return to the position FV shown in Fig. 14.

$$(1+r_0)^n(1+p)$$

times greater than at the outset. The increase in consumption will be smaller, since the relative share of consumption in the national income declines from the initial level of $1-i_0$ to $1-i_n$ at the end of the period of 'recasting'. Therefore consumption increases in the proportion

$$(1+r_0)^n(1+p)\frac{1-i_n}{1-i_0}$$

and its total 'extra growth' resulting from the 'recasting' of fixed capital, will be

$$(1+p)\frac{1-i_n}{1-i_0} \tag{23}$$

Since in the latter expression the first factor is greater and the second smaller than one, it cannot be taken for granted that the product exceeds 1. But if it does not, there is no sense in embarking upon the process of 'recasting', i.e. on raising the capital intensity of the aggregate productive capacity. We shall see that the result of such a 'recasting' depends on the effect of the increase in capital intensity on the productivity of labour. Expression (23) may be rewritten in the form

$$(1+p)\left(1-\frac{i_n-i_0}{1-i_0}\right)$$

Now $i_n - i_0$ is equal to AU in Fig. 14 which in turn is equal to

$$BW = (r_0 + a - u)(k - k_0)$$

Consequently, the raising of the capital–output ratio is justified only if the condition

$$(1+p)\frac{1-i_n}{1-i_0} = (1+p)\left(1-\frac{(r_0+a-u)(k-k_0)}{1-i_0}\right) > 1 \tag{23′}$$

is fulfilled. The increase in consumption will be greater, the greater is the rise in p which results from raising the capital–output ratio from k_0 to k. If the response of the productivity of labour to the rise in capital intensity is weak, the condition (23) is not fulfilled, i.e. there is no increase in consumption.

The average rate of growth of consumption is

$$c = (1 + r_0)\sqrt[n]{(1 + p)}\sqrt[n]{\left(\frac{1 - i_n}{1 - i_0}\right)} - 1 = (1 + r_{av})\sqrt[n]{\left(\frac{1 - i_n}{1 - i_0}\right)} - 1 \quad (24)$$

and is obviously lower than the average rate of growth of the national income. But the latter rate is, according to the above argument, lower than r, i.e. the rate of growth of the national income at the beginning of the period of 'recasting'. Hence we have

$$r > c$$

which means that, during the period of 'recasting', consumption rises on average less rapidly than the national income at the beginning of this period.

This fact has much relevance for the decision as to how far it is desirable to accelerate the growth of national income by means of raising the capital–output ratio. For at the expense of increasing the rate of accumulation by $i - i_0 = AM$ (see Fig. 14) at the outset of the 'recasting' period we obtain an average rate of growth of consumption during this period $c = MZ$ which is lower than $r = MV$ but (according to our assumption about the purpose of 'recasting') higher than r_0, i.e. an 'additional' increase in consumption over n years at an average rate of $c - r_0$.

2. This situation is roughly comparable with that described below arising in the case of unlimited supply of labour. Suppose that in the latter situation the level of the capital–output ratio is such that in order to raise the rate of growth of national income from r_0 to c, i.e. by $c - r_0$, it is necessary to increase the rate of productive accumulation by $i - i_0 = AM$. Suppose, moreover, that after n years we go back to the rate of growth $r_0 = \alpha + \beta$ and thus to the rate of accumulation i_0. Since the relative share of consumption in the national income before the period of accelerated growth and after n years is $1 - i_0$, the increase in consumption from the beginning of the period until the falling back of the rate of growth to r_0 is proportional to the change in the national income. Consequently the average rate of increase in consumption over the n-year period is $c > r_0$.[18] Thus as in the period of 'recasting' considered above the average rate of growth of consumption over the period of n years is increased by $c - r_0$ at the expense of raising the rate of accumulation by $i - i_0$ at the start of the process.

In the subsequent discussion of the choice of the capital–output ratio we shall, on the basis of this analogy, take into consideration the rate of accumulation i conjointly with the average rate of increase in consumption during the 'recasting' period rather than with the rate of growth of the national income at the beginning of this period, and as a first approximation we apply the same decision curve as in the case of an unlimited reserve of labour.[19]

3. In order to solve the problem whether and to what extent it is desirable to increase the capital intensity of the aggregate productive capacity we may use a similar method to that developed in Chapter 4 for dealing with the problem of increasing the rate of growth in the case of an unlimited reserve of labour. Let us first take points V and Z in Fig. 14 corresponding to different values of the capital–output ratio k. We shall then obtain two curves: BV and BZ (see Fig. 15). The former represents the

[18] In fact the course of the process is as follows: consumption falls at the beginning of this period in the proportion $(1 - i)/(1 - i_0)$. Next the national income and consumption grow for n years at a rate c (consumption bearing a constant relation $(1 - i)$ to national income). Finally, after n years when the rate of growth falls back to r_0, consumption increases in the proportion $(1 - i_0)/(1 - i)$.

[19] The application of the same decision curve as in the case of unlimited labour supply is subject to some qualifications. First, in the latter case growth at a rate c may be continued indefinitely while in the case presently considered it may be continued for n years only. (It should be recalled, however, that n is a relatively long period of the order of 20 years.)

A second deficiency in the analogy works in the opposite direction. In the case of an unlimited reserve of labour the fall in the rate of productive accumulation occurs not earlier than at the very end of the period of n years, while in the present case this rate is decreasing throughout. It follows that, although the total increase in consumption for the whole period of 'recasting' is the same in both cases, the shape of the time-curve of consumption within the period is more advantageous in the case presently considered. A further influence in the same direction is exerted by the rate of growth of national income being higher at the beginning of the period of 'recasting' than the average over the whole period. Thus, the case of 'recasting' of fixed capital in n years, when compared to the case of uniform growth (with the rate of growth falling back at the end of this period to its initial level of r_0 and the rate of productive accumulation returning, accordingly, to i_0), has the advantage of an earlier improvement in consumption. At the beginning of the period both processes are similar in that the share of consumption declines in both cases from $1 - i_0$ to $1 - i$. At the end of the period they again become identical with respect to the level of consumption achieved. But in the mid-period the former case gains a clear advantage over the latter.

We ignore these complications below.

relationship between the rate of productive accumulation i and the rate of growth of the national income r at the beginning of the period of 'recasting' n; the latter shows the relationship between the same rate of productive accumulation and the average rate of growth of consumption over the period of 'recasting'. The slope of the straight line joining a point on the curve BV with the point F is equal to the reciprocal of the capital–output ratio.

It should be noticed that the curve BZ reaches a maximum at point S and falls thereafter. The 'additional' relative increase in consumption during the period of 'recasting' amounts according to formula (23′) to

$$(1+p)\,\frac{1-i_n}{1-i_0} = (1+p)\left[1 - \frac{(r_0+a-u)(k-k_0)}{1-i_0}\right]$$

Now, if k is sufficiently high the second factor on the right-hand side of the equation may even approach zero. This means that for a sufficiently large k, c must be negative, i.e. the curve BZ intersects the i-axis and thus it reaches a maximum at some point S. It is clear that in no case must the capital–output ratio exceed the level which corresponds to the point S.

On the lower part of Fig. 15 we now draw the curve $B''Z'$ representing $\Delta c/\Delta i$ for the curve BZ, i.e. the slope of its tangent for a given i. The curve $B''Z'$ will be situated below the horizontal line $B'N'$, as the slopes of all tangents to the curve BZ are less than

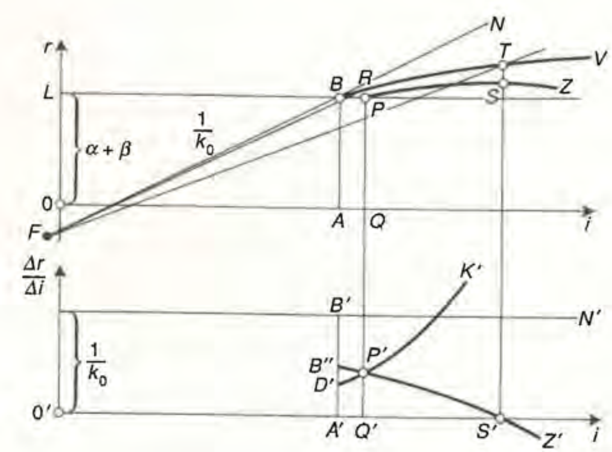

FIG. 15

the slope of the straight line BN. (The slope of a tangent at any point of the curve BV must always be less than $1/k$ which, in turn, is less than $1/k_0$, i.e. than the slope of BN; the slope of a tangent to the curve BZ is in turn smaller than that of the tangent to the curve BV corresponding to the same i.) The curve $B''Y'$ obviously cuts the i-axis at the point S' corresponding to the point S.

Next we draw the 'decision curve' $D'K'$ which—according to the preceding chapter—is the same as that used in the case of an unlimited reserve of labour. The intersection of the two curves at point P' shows the rate of productive accumulation at the beginning of the period of 'recasting'; the projection of this point into the curve BV yields the rate of growth $r = 0R$ at the beginning of this period; and its projection on to the curve BZ, the average rate of growth of consumption c. Finally, the slope of the straight line joining the point R on curve BV with point F yields the capital–output ratio which should be adopted.

The rate of productive accumulation and the rate of growth of consumption are much lower than in the case of a large reserve of labour. Indeed, in the latter case the rate of productive accumulation is determined by the point of intersection of the 'decision curve' and the horizontal line $B'N'$, and the rate of growth of consumption—on the assumption of a return after some long period to the initial rate of growth—by projecting this point on to the straight line BN.

4. If we disregard the question of the level of consumption *during* the period of 'recasting', the optimum solution is the case corresponding to the maximum S of the curve BZ, i.e. the capital–output ratio corresponding to the straight line FT. For in this way we obtain the highest possible average rate of growth of consumption over n years; this is tantamount to reaching the highest level of consumption which may be achieved given the supply of labour and the rate of growth $\alpha + \beta$ which will exist at the end of the period of 'recasting'. Many authors, especially in the West, concentrated their attention on this solution which was even nicknamed the 'golden rule'. However, it follows from our argument that this solution is purely theoretical in character because the key problem in the choice of capital intensity is the standard of living *in the course* of 'recasting'. The ascending 'decision curve' which allows for this factor leads, as we saw above, to the

adoption of a much lower capital intensity and a lower average rate of growth of consumption during the period of 'recasting'.

It may be the case, at least theoretically, that in the initial position the capital intensity of aggregate productive capacity corresponds to a point on the curve *BZ* situated to the right of *S*; the curve *BZ* is thus downward sloping. The curve *B″Z′* in the lower part of the diagram is then situated below the abscissa axis and obviously cannot intersect the curve of decision to the right of the initial position. This corresponds to the case, discussed above (section 1 of this chapter) of non-fulfilment of the criterion

$$(1+p)\frac{1-i_n}{1-i_0} > 1 \tag{25}$$

In this case it is definitely advantageous to 'recast' aggregate equipment in order to *reduce* its capital intensity; this causes consumption to grow at a rate higher than r_0 in both the short and the long run.[20]

5. As in Chapter 4, section 3, we shall now discuss the problem of gradually achieving the increased rate of productive accumulation required at the beginning of the period of 'recasting'. Again we may imagine that this is being done over transition period τ by using the gain from the normal increase in labour productivity resulting from technical progress (we denoted this rate of increase by α) exclusively for accumulation. This is the same assumption as we made when discussing the problem of accelerating growth by drawing on the reserve of labour.[21]

[20] Cf. Kazimierz Łaski, 'Temporary Slowing Down of the Growth and the Dynamics of Consumption in a Socialist Economy', *Ekonomista*, 57/4, 1964 (in Polish).

[21] It should be noted, however, that there it meant the stabilization of real wages in the transition period, so that consumption grew *pari passu* with employment in this period. Here the situation is somewhat different. The acceleration of growth is based on a gradual increase in the capital intensity of investment and thus of labour productivity in new plant. As only the normal increase in labour productivity at a rate α is absorbed by productive accumulation, the additional increase in productivity serves to increase both consumption and accumulation in the same proportion. As a result, real wages do not remain stable throughout the transition period, but increase *pari passu* with the additional rise in productivity. This rise in real wages is in a way a counterpart to the rise in consumption during the transition period, which results from the acceleration of the increase in employment in the case of drawing on a reserve of labour.

It is clear that, as in the latter case, the transition period τ will be shorter, the higher the 'normal' rate of growth of labour productivity α resulting from technical progress.

6. It follows from the above that during the transition period the rate of growth of national income increases, but next declines over the *n*-year period of 'recasting', and at the end of this period the rate of growth falls back to its initial level. During the transition period τ the relative share of productive accumulation in the national income increases, i.e. this accumulation, and particularly that of fixed capital, rises more rapidly than the national income. In the period of 'recasting' the process is reversed; the relative share of productive accumulation in the national income declines (although not to its initial level), so that productive accumulation increases less rapidly than the national income.

The question arises whether or not it would be possible to avoid the slackening of growth of national income in the period of 'recasting' and to maintain the rate reached at the end of the transition period. This is clearly impossible if the capital–output ratio, having been raised from k_0 to k in the transition period, remains thereafter at the same level, as has been assumed so far in our argument. For it follows from our preceding discussion that it is the rise in the capital–output ratio to a higher level that leads to an acceleration of growth, but that the *maintenance* of this ratio *at a constant level* thereafter is accompanied by a decline in the rate of growth back to the initial level.

From this it may in turn be concluded that it is possible to maintain the rate of growth of the national income at the level reached in the transition period if the capital–output ratio is increased steadily; the tendency of the rate of growth to decrease may then be counteracted by the effect of an adequate increase in the capital–output ratio on the productivity of labour. Obviously, the maintenance of a constant rate of growth of national income, based on a steadily rising capital–output ratio, will also call for a steady rise in the rate of productive accumulation.

Although it is possible in this way to keep the rate of growth at a constant level, it does not follow that such a policy is always sensible. It would clearly be unreasonable to continue such a process *ad infinitum*. Indeed, the steady increase in the rate of productive accumulation would ultimately bring the relative share of consumption in the national income down to zero, which would, of course, be absurd. Much earlier than that total consumption would begin to decrease, and *per capita* consumption earlier still. Thus it is clear that a policy of maintaining the rate of growth at a level higher than $r_0 = \alpha + \beta$ is conceivable only for a limited period. Sooner or later it must become necessary to put an end to the rise in the capital–output ratio, which will lead to a gradual slowing down in the growth of the national income, until it reaches the level r_0 as determined by the 'normal' growth of productivity of labour (resulting from technical progress) and the natural increase in the labour force.

If, however, there must sooner or later be a return to the rate of growth $\alpha + \beta$, this process must not be continued beyond the point of optimum capital intensity corresponding to the 'golden rule'. Moreover, there may be, and probably will be an even earlier decision to stabilize the capital intensity in order to achieve the gain in consumption sooner (cf. section 4 of this chapter).

7. So far we have been dealing with the problem of accelerating the growth of national income by raising the capital–output ratio on the assumption of neutral technical progress. We shall now consider the same problem for the case of technical progress 'encouraging capital intensity'.

In this case by adjusting aggregate productive capacity to a higher capital intensity we raise not only the average labour productivity but also the rate of its increase. For, after having completed the 'recasting' of aggregate capital equipment there is achieved not only a higher level of average productivity of labour (as in the case considered above), but also a higher future rate of increase in productivity than in the initial position, i.e. higher than α. Changes tending in this direction also occur throughout the course of 'recasting', because of the faster increase in productivity in the new plant. The effect of this is the greater, the more advanced the process of 'recasting'. At the beginning of the period of 'recasting' the influence of this factor is negligible. The fact that labour productivity in plant brought into operation in the first year exceeds that of the preceding year by α' (say, 5%) rather than by α (say, 4%) only slightly affects the growth of labour productivity in the economy as a whole; quantitatively much more

important is the fact that the *level* of productivity in new plant is increased in the proportion $1 + p$ after the start of 'recasting'. But at the end of the period of 'recasting' the rate of increase in *average* productivity is α' rather than α. The rising importance of the higher *rate of increase* in labour productivity in new plant neutralizes to some extent the tendency of growth due to the increased *level* of productivity of this plant to decline over the course of the period of 'recasting' (as described in our analysis of the case of neutral technical progress). The rate of increase in average productivity does not, therefore, decline to the initial level but to the level α' which is higher than α.

The corresponding rate of growth of national income declines from the level r to the level $r_0 + \alpha' - \alpha$ which is higher than the initial rate r_0. This situation is represented in Fig. 16 which is similar to Fig. 14. In the present case the point depicting the rate of productive accumulation and the rate of growth of national income moves from V to Y rather than to W (as it did in the case of neutral technical progress) during the period of 'recasting'. But, as we shall see, the point W still retains some significance.

What benefits in the form of a faster long-run growth of consumption may be obtained in this case at the cost of raising the rate of productive accumulation at the beginning of the period of 'recasting' from i_0 to i (i.e. increasing i from $0A$ to $0M$)?

In the case of neutral technical progress we defined this benefit as the increase in the average rate of growth of consumption over the period of 'recasting'. We indicated there the similarity between achieving the extra growth of consumption in this way over a period of 'recasting', and raising the rate of growth of national income from r_0 to c by increasing the rate of productive accumu-

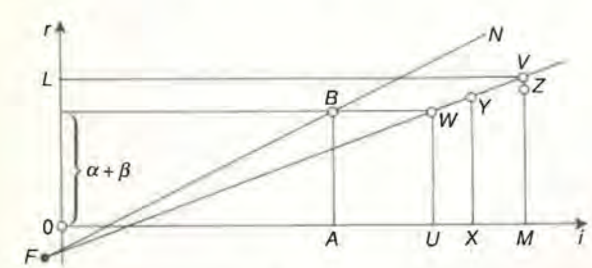

FIG. 16

lation by $i - i_0$ in the case of an unlimited reserve of labour (on the assumption that the rate of growth falls back to r_0 after n years); on this basis we applied the same 'decision curve' to the problem of the choice of capital intensity and the rate c as in the case of an unlimited reserve of labour. We would like to proceed in a similar fashion in the present case of technical progress 'encouraging capital intensity', but the following complication arises.

The rate of growth does not fall back to the initial level $r_0 = \alpha + \beta$ after the period of 'recasting', but to a higher level $\alpha' + \beta = r_0 + \alpha' - \alpha$. As a result, the relative share of productive accumulation in the national income, $0X$, is greater than the level $0U$ corresponding to r_0, and thus the relative share of consumption is correspondingly reduced. Consequently, in order to be able to apply our previous argument we have to make the case presently considered comparable to the case of 'recasting' under conditions of neutral technical progress. For this purpose let us suppose that after the period of 'recasting' the rate of increase of the labour force is reduced to the level

$$\beta' = \beta + \alpha - \alpha'$$

by means of a steady reduction in hours worked. Then

$$\beta' + \alpha' = \beta + \alpha = r_0$$

(Obviously this case is not quite equivalent to the return to the rate r_0 in the case of neutral technical progress because of the benefit of the gradual reduction in hours worked after the end of the period of 'recasting', but in view of the remoteness of the time when the benefit will accrue, the difference is not very important.) The rate of productive accumulation will then drop to the level $0U$ corresponding to r_0, and the relative share of consumption in the national income will rise *pro tanto*. We now have no difficulty in following our previous line of argument, i.e. we may relate the rate of growth of consumption c to the rate of productive accumulation at the beginning of the period of 'recasting' and apply the same 'decision curve' as in the case of an unlimited reserve of labour.

As above, let us denote the average rate of growth of national income over the period of 'recasting' by r_{av}. The average rate of increase in consumption (in the sense just discussed) is

$$c = (1 + r_{av}) \sqrt[n]{\left(\frac{1 - i_n}{1 - i_0}\right)} - 1$$

where i_n is the rate of accumulation which would obtain if the rate of growth returned to the level r_0 (in other words it is the abscissa of the point W). But is this not exactly the same result as in the case of neutral technical progress? The answer here is definitely negative; the rate of increase in productivity in new plant, α', which is higher than α, exerts its influence throughout the period of 'recasting' and thus neutralizes to some extent the tendency of the rate of growth of national income to decline. Consequently r_{av} is greater than in the previous case of neutral technical progress, where it was equal to

$$r_{av} = (1 + r_0) \sqrt[n]{(1 + p)} - 1$$

and as a result the average rate of growth of consumption is also greater. (The difference will, clearly, be more marked, the greater the difference $\alpha' - \alpha$.) This average rate of growth of consumption is represented in Fig. 16 by the point Z, its abscissa being i and its ordinate c.

We may now construct a diagram similar to Fig. 15. Again we draw the curve BV for the rate of growth r at the beginning of the period of 'recasting'; this curve is the locus of the point V in Fig. 16. The curve BY which represents the rate of growth at the end of the period (i.e. $r_0 + \alpha' - \alpha$) is the locus of the point Y. The latter curve is upward sloping since, according to our definition of technical progress 'encouraging capital intensity', the rate of increase in productivity α' is greater, the higher the capital–output ratio k. Finally, the curve BZ represents the average rate of growth of consumption c (on the assumption that, after the end of the period of 'recasting' the current rate of growth $r_0 + \alpha' - \alpha$ will be reduced to r_0). This curve is the locus of the point Z and, as follows from our argument, it is situated above the curve BZ of Fig. 15 corresponding to the case of neutral technical progress. For this very reason the rate of productive accumulation i, determined in Fig. 17 by the point of intersection P' of the 'decision curve' and the curve $\Delta c/\Delta i$, is higher than in the case of neutral technical progress, and so is the average rate of growth of consumption c. Obviously, the capital–output ratio

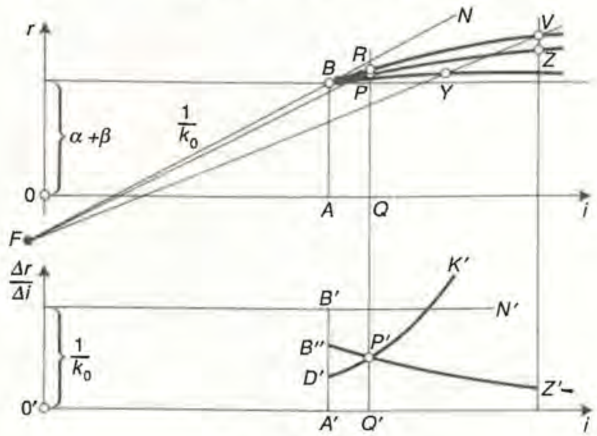

FIG. 17

k (being the reciprocal of the slope of the straight line FR) is also greater than it was in that case. This means that in our present case a higher capital–output ratio will be chosen, because *ceteris paribus* we obtain a greater increase in consumption. This is to be expected, as we are dealing here with technical progress 'encouraging capital intensity'.[22]

9. Increasing the Rate of Growth of National Income under Conditions of Full Employment through a Reduction in the Life-Span of Equipment

1. We shall consider now the problem of accelerating the growth of the national income by increasing the average productivity of labour through a reduction in the life-span of equipment from n to n' years. As a result of a shorter life-span of equipment average productivity is raised to a higher level because aggregate fixed capital is, on the average, made 'younger' and thus techniques of production are more up-to-date. The process of 'rejuvenating' the stock of capital equipment is achieved by intensifying the scrap-

[22] In the case of technical progress 'encouraging capital intensity' it is impossible to show, as in sect. 3, that the curve of the average rate of growth of consumption BZ has a peak, because this rate tends to increase along with α' which in turn is an increasing function of capital intensity (see preceding page). Thus the problem of the 'golden rule' does not arise in this case.

ping of existing productive capacity in the proportion a/a_0 where a_0 is the parameter of depreciation corresponding to a life-span of n years and a constant rate of growth r_0, whilst a is the parameter corresponding to the same rate of growth and a life-span of n' years (see Chapter 7, section 5). During the period of 'rejuvenation' which lasts n' years, there is an additional increase in the productivity of labour in the proportion $1 + p$. As in the case of neutral technical progress, the increase in the rate of growth of national income, $r - r_0$, equal to the increase in the rate of growth of average productivity, is highest at the beginning of the period of 'rejuvenation' and declines gradually throughout the process, since the extra scrapping applies to less and less obsolete plant. Finally $r - r_0$ reaches zero, when the process of 'rejuvenation' is complete.[23] But the rate of productive accumulation i_n is higher than in the initial situation, i.e. than i_0, since the reduced life-span of fixed capital involves higher investment.

The necessary precondition for such an operation to be worth carrying out is again

$$(1 + p)\,\frac{1 - i_{n'}}{1 - i_0} > 1 \tag{26}$$

which means that it brings about an additional increase in consumption. The difference between the present case and that of 'recasting' of the stock of capital with neutral technical progress is that the rate of productive accumulation is raised from i_0 to $i_{n'}$ not because of the increased capital–output ratio k, but as a result of the rise in the parameter of depreciation a which represents the rate of contraction of the national income caused by scrapping old plant. The inequality given above may be rewritten in the form

$$(1 + p)\left(1 - \frac{i_{n'} - i_0}{1 - i_0}\right) > 1$$

We may determine $i_{n'} - i_0$ from our equations for r_0 at the beginning and at the end of the period of rejuvenation

$$r_0 = \frac{1}{k}\, i_0 - \frac{m}{k}\,(a_0 - u)$$

[23] As shown in n. 15 above, the system is then poised for uniform growth at a rate r_0.

$$r_0 = \frac{1}{k} i_{n'} - \frac{m}{k}(a - u)$$

From this we derive

$$i_{n'} - i_0 = m(a - a_0)$$

Thus our precondition for the 'rejuvenation' of the aggregate fixed capital to be worth carrying out may be written in the form

$$(1 + p)\left(1 - \frac{m(a - a_0)}{1 - i_0}\right) > 1 \qquad (27)$$

The process of 'rejuvenation' can be represented diagrammatically analogously to Fig. 14. The parameter of depreciation increases from a_0 to a (which is reflected in a parallel downward shift of the line CN).[24] At the beginning of the period of 'rejuvenation' we obtain a higher rate of growth of national income r with a considerably increased rate of productive accumulation i (see Fig. 18). During the period of 'rejuvenation', the point representing the rate of accumulation and the rate of growth of the national income moves gradually from V to W.[25] As a result, the rate of growth is brought back to its initial level r_0, with a higher rate of

[24] This is strictly true only at the beginning and end of the 'rejuvenation' process (cf. n. 17 above).

[25] It should be noted that the presentation of the process of 'rejuvenation' in Fig. 17 is not quite accurate. The point X is not in fact fully immobile in the course of this process. Indeed, the productive capacities P_1, P_2, etc. existing in the initial position (cf. n. 15 above) form a geometrical progression with a quotient

$$(1 + r_0)/(1 + u).$$

The same is true of capacities scrapped, i.e. of

$$\frac{a}{a_0} P_1, \ \frac{a}{a_0} P_2, \ldots$$

The corresponding actual losses of output will also form a geometrical progression but its quotient will be

$$\frac{1 + r_0}{1 + u} \cdot (1 + u) = 1 + r_0$$

because of the operation of the factor u. However, in the course of the process of 'rejuvenation' the rate of growth of the national income is higher than r_0. As a result the point X moves upwards and the straight line XV also shifts upwards, but without changing its slope. At the end of the period of 'rejuvenation' there will be a return to the position XV shown in Fig. 18.

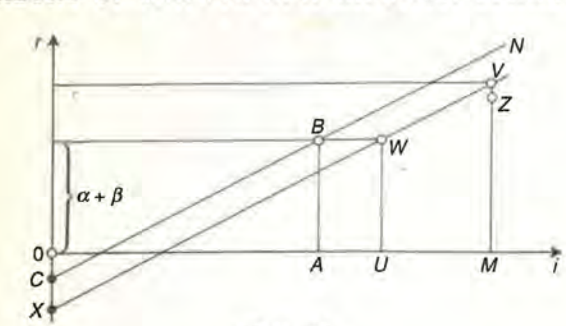

FIG. 18

productive accumulation. Fig. 18 also shows the point Z whose ordinate c, the average rate of growth of consumption, is determined by the formula

$$(1 + p)\sqrt[n']{\left((1 + p)\frac{1 - i_{n'}}{1 - i_0}\right)} - 1$$

while its abscissa is the rate of productive accumulation at the beginning of the period of 'rejuvenation'.

It must be recalled that to different parameters of depreciation a there correspond not only different p and $i_{n'}$ but also different 'rejuvenation' periods n'.

2. We may now construct a diagram similar to Fig.15 which shows the choice of the capital–output ratio in the case of neutral technical progress. In the upper part of the diagram (see Fig. 19) we draw the curves of the rate of growth of the national income at the beginning of the period of rejuvenation r and of the average rate of growth of consumption c. Since this average is calculated for different periods n' (n' is shorter, the higher is a) we must modify the 'decision curve' as was done in the case of a limited reserve of labour. For the further we move to the right, the shorter becomes the period during which consumption grows at the average rate c, and this rate must therefore be appreciated less (see Chapter 5, section 2). Accordingly, the 'decision curve' $D'K'$ is replaced by another 'decision curve' $D'H'$. The point of intersection of the curves $D'H'$ and $B''Z'$ again determines i, c, and r. Drawing a parallel to the line CN through the point R we obtain the increase in the parameter of depreciation $a - a_0$ (equal to the distance CX divided by m/k).

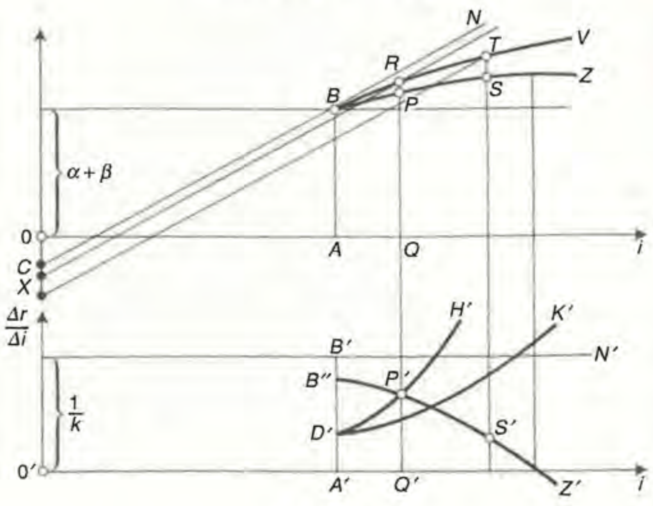

FIG. 19

3. According to formula (27) the additional increase in consumption from the initial position to the end of the process of 'rejuvenation' is equal to

$$(1+p)\frac{1-i_{n'}}{1-i_0} = (1+p)\left[1 - \frac{m(a-a_0)}{1-i_0}\right]$$

It is clear that this expression—which in the case of a rational reduction of the life-span of equipment is greater than one—has a maximum for a certain n'. Indeed, if the intended life-span of equipment n' is already very short, so that average productivity in the economy is very close to that in the new plant, a further considerable relative reduction in n' raises p only negligibly although the parameter of depreciation a shows a significant increase. This means that the first factor of the expression on the right-hand side increases very little while the second one declines considerably.

Thus there arises here a situation similar to that in the case of 'recasting' under conditions of neutral technical progress discussed above where the increase in consumption reaches a maximum for a certain capital intensity according to the expression

$$(1+p)\frac{1-i_{n'}}{1-i_0} = (1+p)\left[1 - \frac{(r_0+a-u)(k-k_0)}{1-i_0}\right] \qquad (23')$$

But in contrast to that case, the maximum 'once-for-all' increase in consumption attainable in the present case of 'rejuvenation' of fixed capital *does not* correspond to the highest point on the curve BZ. The average rate of growth of consumption during the period of 'rejuvenation' given by BZ increases towards a maximum as n' falls for two reasons: (i) because of the increase in the expression

$$(1+p)\left[1 - \frac{m(a-a_0)}{1-i_0}\right]$$

and (ii) because of the reduction in the length of the 'rejuvenation' period which is equal to n'. As a result the highest point on the curve BZ will be reached at a point of more intensive 'rejuvenation', i.e. at a higher a, than that corresponding to the maximum absolute increase in consumption; this means that the highest attainable level of consumption after the period of 'rejuvenation' corresponds to a point S situated to the left of the peak of the curve BZ (see Fig. 19).

However, as in the case of 'recasting' fixed capital with neutral technical progress, the degree of 'rejuvenation' of aggregate capital equipment chosen by the government according to Fig. 19 will be lower than that which assures the maximum level of consumption after the process of 'rejuvenation' (and obviously this will be even more the case with regard to the degree of 'rejuvenation' which produces the highest average rate of growth of national income over the period of 'rejuvenation').

4. We considered above the process of 'recasting' to obtain a higher capital intensity of aggregate productive capacity with a given life-span of equipment and the process of 'rejuvenation' of fixed capital with a given capital intensity. A more general procedure for accelerating the growth of national income would be a combination of the two processes. Such a 'transformation' of fixed capital would consist of a simultaneous raising of the capital intensity from m_0 to m, and of the parameter of depreciation from a_0 (corresponding to a life-span of equipment n) to a (corresponding to a life-span of equipment n'). As this essay deals merely with basic and relatively simple elements in the theory of growth for a socialist economy, we shall confine ourselves here to the problem of the optimum capital intensity (assuming neutral technical progress) and life-span of equipment without allowing for 'sacrifices' of consumption *in the course* of the 'transformation' process. This is a generalization of the problems considered above, of the optimum capital intensity of equipment with a given life-span, and vice versa (Chapter 8, section 4 and the preceding section of this chapter).

In the initial position we have

$$r_0 = \alpha + \beta = \frac{i_0}{k_0} - \frac{m_0}{k_0}(a_0 - u) \tag{28}$$

Let us denote the rate of productive accumulation in the optimum position by i' and the proportional increase in the average labour productivity resulting from raising the capital intensity and reducing the life-span of equipment by $1 + p$. According to Chapter 8, section 1 and section 1 of this chapter the proportional extra increase in consumption during the 'transformation' period will be

$$(1 + p)\frac{1 - i'}{1 - i_0} = (1 + p)\left(1 - \frac{i' - i}{1 - i_0}\right)$$

After the period of 'transformation' (assuming neutral technical progress) we have

$$r_0 = \alpha + \beta = \frac{i'}{k} - \frac{m}{k}(a - u) \tag{29}$$

where $k - k_0 = m - m_0 > 0$ as a result of raising the capital–output ratio, and $a - a_0 > 0$ as a result of reducing the life-span of equipment. From equations (28) and (29) we obtain

$$(k - k_0)r_0 = i' - i_0 - (ma - m_0a_0) + (m - m_0)u$$

and taking into consideration that $k - k_0 = m - m_0$

$$\begin{aligned} i' - i_0 &= (m - m_0)(r_0 - u) + (ma - m_0a) + (m_0a - m_0a_0) \\ &= (m - m_0)(r_0 - u + a) + m_0(a - a_0) \end{aligned}$$

Hence the extra proportional increase in consumption is

$$(1 + p)\left[1 - \frac{(m - m_0)(r_0 - u + a) + m_0(a - a_0)}{1 - i_0}\right]$$

Now, the higher are $m - m_0$ and $a - a_0$, the greater is $1 + p$, but the smaller the second factor. The point at which the product reaches its maximum—and it follows from the argument in Chapter 8, section 4 and in section 3 of this chapter that there does

exist a combination m and a for which this occurs—is an optimum solution both with regard to the capital intensity and the life-span of equipment. In this position a given labour force increasing at a rate β, with productivity increasing at a rate α as a result of technical progress, will secure the highest possible consumption increasing at a rate $\alpha + \beta$. This will therefore give the highest possible real wage increasing at a rate α.

As implied above in the consideration of an optimum m for a given n and vice versa the achievement of this 'paradise' may, however, prove to be too costly from the point of view of consumption in the short run, during the 'transformation' of fixed capital.

It should still be borne in mind that to achieve a complete presentation of the problems of 'recasting' and 'rejuvenation' of fixed capital, the problem of foreign-trade difficulties should be superimposed on these processes. These difficulties naturally restrain the government's tendency to accelerate the growth of national income in this way; but, as we have repeatedly stated, this essay deals merely with the basic elements in the theory of growth for a socialist economy, and we shall not embark here upon a detailed discussion of this subject.[5]

10. The Problem of Choice of the Capital–Output Ratio under Conditions of an Unlimited Supply of Labour

1. In the two preceding chapters we dealt with the problem of accelerating the growth of national income under conditions of full employment. It was shown that, at least for the period of 'recasting', such an acceleration may be achieved by raising the capital–output ratio so as to increase labour productivity in new plant. In the case of an unlimited supply of labour the rate of national income can be increased without changing the capital–output ratio by accelerating the increase in employment. It was on this assumption that we based our discussion in Chapter 4. However, from the fact that it is possible in this way to increase the rate of growth of national income over and above the level $r_0 = \alpha + \beta$ (i.e. that determined by the increase in productivity resulting from technical progress and the natural increase in the labour force), it does not necessarily follow that this is the best method to choose.

It is easy to envisage here the possibility of reducing the capital–output ratio by fuller utilization of existing labour resources (if these possibilities have not already been exhausted). We shall examine this problem in detail below, but first we shall deal with the views of Dobb and Sen on the subject. These authors drew attention to the fact that, on certain assumptions, it may be reasonable to *raise* the capital–output ratio even in the case of an unlimited supply of labour.[26] Their argument, adapted to the approach used in this essay, may be presented as follows.

Suppose that the government aims at the fastest possible rate of economic development without resorting to a reduction in real wages. It thus decides to maintain these wages at a constant level for a long period, while using the whole increase in labour productivity to raise the rate of accumulation. We discussed above (see Chapter 4, section 5) such an increase in the rate of accumulation based upon the rise in labour productivity resulting from technical progress during the 'transition period' τ. But it is also possible for this increase in the share of productive accumulation in the national income to be reinforced by 'recasting' the stock of equipment in order to raise its capital intensity; this would result in an additional increase in productivity in the relevant period. When the capital–output ratio is maintained at its initial level k_0 the increase in the national income relative to consumption after n years is raised in the proportion $(1 + \alpha)^n$ (cf. Chapter 4, section 5).[27] But if we superimpose upon this the process of 'recasting' which brings the capital intensity up to the level k, the national income will be increased in relation to consumption in the proportion $(1 + \alpha)^n(1 + p)$, where p is the proportional increase in productivity in the new plant resulting from raising the capital–output ratio from k_0 to k.[28] Let us denote by i_0 the rate of productive accumulation in the initial position; by π_n the rate of accumulation n years later with the capital–output ratio remaining

[26] See M. Dobb, *An Essay on Economic Growth and Planning*, London, Routledge & Kegan Paul, 1960; A. K. Sen, *Choice of Techniques*, Oxford, Blackwell, 1960.

[27] In fact average productivity increases in a proportion somewhat higher than $(1 + \alpha)^n$ because the acceleration of growth of the national income causes some decline in the average 'age' of equipment. We shall get round this complication by using this slight increase in average productivity to raise real wages somewhat.

[28] Cf. n. 27 above.

unchanged at the level k_0; and by π_n' the rate of accumulation n years later, but on the assumption that the stock of equipment has been 'recast' in order to raise its capital intensity to k. We then have

$$i_0 < \pi_n < \pi_n'$$

The respective rates of growth of national income will be as follows

$$r_0 = \frac{1}{k_0} i_0 - \frac{m_0}{k_0}(a - u)$$

$$r_n = \frac{1}{k_0} \pi_n - \frac{m_0}{k_0}(a_n - u)$$

$$r_n' = \frac{1}{k} \pi_n' - \frac{m}{k}(a_n' - u)$$

It is clear that $r_n > r_0$, but it cannot be taken for granted that $r_n' > r_n$. It is true that the rate of accumulation π_n' is higher than π_n, but on the other hand, $k > k_0$ which adversely affects the rate of growth. If we disregard the relatively small difference between the terms

$$\frac{m_0}{k_0}(a_n - u) \qquad \text{and} \qquad \frac{m}{k}(a_n' - u)$$

we obtain the following condition for r_n' to be greater than r_n

$$\frac{\pi_n'}{k} > \frac{\pi_n}{k_0}$$

In other words, the necessary condition for achieving a higher rate of growth as a result of adjusting fixed capital to a higher capital intensity is a greater relative increase in the rate of accumulation than in capital intensity. Even if such is the case, however, it is not by itself a conclusive argument for raising the capital–output ratio; in addition we must take into account (as we do throughout this essay) not only what happens in the long run, i.e. in this case at the end of the n-year period of 'recasting', but also what will occur in the near future. Now, the rate of growth at the *beginning* of the period of 'recasting' is

$$r_0' = \frac{1}{k} i_0 - \frac{m}{k}(a - u)$$

since the rise in the productivity of labour (resulting either from technical progress or from raising the capital–output ratio) is not yet able to affect the rate of accumulation. It is clear that the rate of growth due to the rise in the capital–output ratio, r_0', is lower than $r_0 = \alpha + \beta$. Consequently in this period an increase in unemployment will occur, the rate of growth of the national income being lower than the rate of increase in labour productivity plus the natural rate of growth of the labour force. Thus it is not at all certain that the government will decide to raise the capital–output ratio, even if this would bring about a substantial increase in the rate of growth at later stages of the process of 'recasting'. Moreover, we shall try to show that the idea of raising the capital–output ratio, given a reserve of labour, would probably yield no benefits even in the long run unless the rate of increase in labour productivity resulting from technical progress, α, is very small. As a matter of fact neither Dobb nor Sen took this type of increase in productivity into consideration at all; they assumed the rise in productivity to be achieved solely by raising the capital–output ratio.

In order to examine the problem of an optimum capital–output ratio under conditions of unlimited labour supply we shall again use a diagrammatic presentation. We shall begin with the case discussed by Dobb and Sen when $\alpha = 0$.

2. The ratio of national income to consumption is $1/(1 - i)$, since i being the rate of productive accumulation, the relative share of consumption in the national income is $1 - i$. Hence, initially this ratio is equal to $1/(1 - i_0)$, while at the end of the period of 'recasting' it equals $1/(1 - \pi_n')$. Since for the time being we disregard technical progress, so that $\alpha = 0$, the national income per worker will increase over the period of 'recasting' in the proportion $1 + p$. Since real wages are kept constant, the ratio of the national income to consumption will also increase in the proportion $1 + p$. Thus we have

$$\frac{\dfrac{1}{1 - \pi_n'}}{\dfrac{1}{1 - i_0}} = 1 - p$$

or

$$1 - \pi_n' = \frac{1 - i_0}{1 + p}$$

and

$$\pi_n' = 1 - \frac{1 - i_0}{1 + p} \qquad (30)$$

We now plot k as the abscissa and

$$\frac{1 - i_0}{1 + p}$$

as the ordinate (see Fig. 20). To the abscissa $k_0 = 0D$ there corresponds the ordinate $1 - i_0 = BD$, as in this case the capital–output ratio has not been raised and $p = 0$. It is clear that the curve BT is simply a production curve like that in Fig. 11, p. 53, except that it is shifted to the right and the scale of the ordinate axis is different. Indeed, employment per unit increment in national income is proportional to the reciprocal of $1 + p$ which is the index of labour productivity in new plant. Moreover, k is the sum of $m + \mu$ where m is the capital–output ratio for investment in fixed capital and μ the corresponding ratio for the increase in inventories. When m increases μ remains unaltered, so that the production curve in Fig. 20 is shifted to the right by a distance μ as compared with that in Fig. 11 (i.e. m in Fig. 11 corresponds to $m + \mu$ in Fig. 20).

It follows from formula (30) that for a given k the rate π_n' is equal to the distance MN between the curve BT and the horizontal

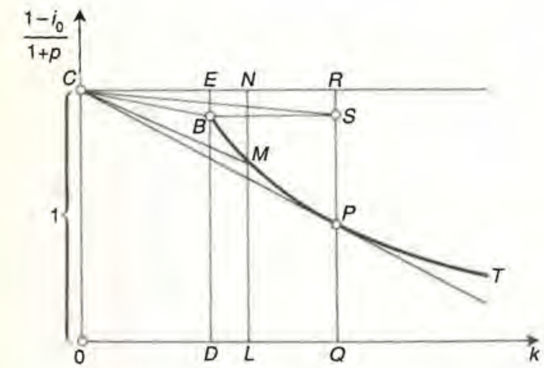

FIG. 20

line CN drawn at a distance equal to 1 from the k-axis. Hence the slope of the segment CM equals π_n'/k, since

$$MN = \pi_n' \quad \text{and} \quad 0L = CN = k.$$

As shown above, the ratio π_n'/k determines the rate of growth at the end of the period of 'recasting'.

It is now easy to answer the question how far the capital–output ratio should be raised in order to maximize the rate of growth at the end of the period of 'recasting' in the case represented by Fig. 20. The slope of the straight line joining the point C with any point on the curve BT is greatest at the point P, i.e. when the straight line is a tangent to the curve BT. Hence the capital–output ratio should be raised to the level shown by the abscissa of point P, i.e. $0Q$, but not beyond this point.[29]

This is not, however, the end of the problem as we must also see what happens in the early stages of 'recasting'. If the capital–output ratio were not raised at all, the rate of growth would be determined by the ratio i_0/k_0 which is represented in the diagram by the slope of the straight line CB. (It must be recalled that $BD = 1 - i_0$, so that $EB = 1 - (1 - i_0) = i_0$, while $0D = CE = k_0$.) However, when the capital–output ratio is raised to the level $k = 0Q = CR$, then at the beginning of the period of 'recasting' instead of i_0/k_0 we have the ratio i_0/k which is represented by the slope of the straight line CS. Thus we gain a higher rate of growth in the long run (this is shown by the difference between the slopes of the straight lines CP and CB), but we lose in terms of the near future (as shown by the difference between the slopes of the straight lines CB and CS).

In this case the government would probably choose a capital–output ratio somewhere between the levels $k_0 = 0D$ and $k = 0Q$, or might decide after all to maintain the level k_0.

3. We shall now take into account the increase in the productivity of labour resulting from technical progress, confining ourselves to the case where this progress is neutral; we shall see that the situation is radically changed even when the rate of growth of productivity is rather slight. The ratio of national income to

[29] The rate of growth equal to the slope of CP is closely akin to that yielded by J. von Neumann's model because it is the highest rate of growth under conditions of an unlimited supply of labour with a given constant real wage.

consumption will then increase over n years in the proportion $(1 + \alpha)^n (1 + p)$, real wages remaining constant.[30] (Since we assumed neutral technical progress, the rate of growth of productivity, α, does not depend upon the capital–output ratio.) Thus we now have

$$\frac{\dfrac{1}{1 - \pi_n'}}{\dfrac{1}{1 - i_0}} = (1 + \alpha)^n (1 + p)$$

or

$$1 - \pi_n' = \frac{1 - i_0}{1 + p} \cdot \frac{1}{(1 + \alpha)^n}$$

and thus

$$\pi_n' = 1 - \frac{1 - i_0}{1 + p} \cdot \frac{1}{(1 + \alpha)^n} \tag{31}$$

If we do not raise the capital–output ratio above the level k_0, then $p = 0$ and the rate of growth after n years obtained from formula (31) results from the increase in productivity which is due solely to technical progress, real wages remaining constant

$$\pi_n = 1 - (1 - i_0) \frac{1}{(1 + \alpha)^n}$$

We shall now represent diagrammatically the relationship between

$$\frac{1 - i_0}{1 + p} \cdot \frac{1}{(1 + \alpha)^n}$$

and k, analogously to Fig. 20. We begin by drawing the curve

$$\frac{1 - i_0}{1 + p}$$

(identical to BT in Fig. 20). We then divide its ordinates by $(1 + \alpha)^n$ and thus obtain the curve $B'T'$. (We assumed here that α took the relatively low level of 2.5% and that $n = 20$ years; hence $(1 + \alpha)^n$ is equal to 1.65 and it is this figure that was used to

[30] Or rather, increasing somewhat; cf. n. 27 above.

deflate the ordinates of the curve BT in the diagram.) For any given k the rate π_n' is now equal to the distance NM' between the curve $B'T'$ and the horizontal line CN which is drawn at a unit distance from the k-axis. To $k_0 = 0D$, there corresponds

$$\pi_n = B'E = (1 - i_0)\frac{1}{(1 + \alpha)^n}$$

since in this case $p = 0$.

The slope of the straight line CM' which joins the point C with the point M' on the curve $B'T'$ represents the ratio π_n'/k. In particular it should be noted that the slope of the straight line CB' is equal to π_n/k_0. Finally, the slopes of the straight lines CB and CK represent the ratios i_0/k_0 and i_0/k respectively (cf. Fig. 20). It is clear that in the case represented in Fig. 21 it is not desirable to raise the capital–output ratio above the level k_0. Indeed, when the point M' moves to the right along the curve $B'T'$ the slope of the straight line CM' diminishes; this means that $\pi_n'/k < \pi_n/k_0$ so that raising the capital–output ratio leads to a decrease in the rate of growth of national income at the end of the period of 'recasting'. Obviously the same is true of the rate at the beginning of this period (the slope of the straight line CK is smaller than that of the straight line CB).

Thus it may be seen that, while in the case of $\alpha = 0$ (as depicted by Fig. 20) the rate of growth at the end of the period of 'recasting' is at a maximum for a capital–output ratio about twice as high as that in the initial situation—with a moderate increase

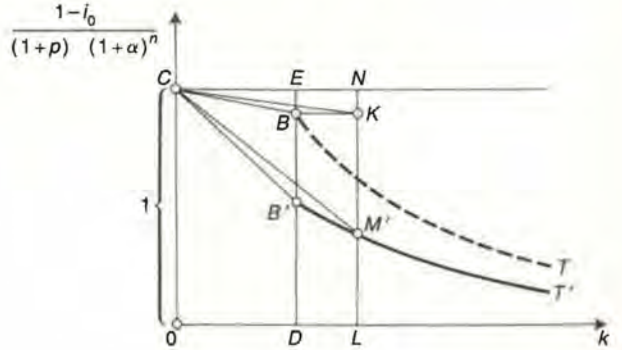

FIG. 21

in productivity ($\alpha = 2.5\%$ p.a.) resulting from technical progress, this rate of growth is adversely affected by a rise in the capital–output ratio. Thus technical progress, as reflected in the downward shift of the curve of production, considerably reduces the practical significance of the Dobb–Sen approach.

4. We have so far assumed that real wages remain unaltered for a very long period so that consumption rises only as a result of increasing employment. Such an assumption is not very realistic. When considering economic growth with a reserve of labour in Chapter 4 we assumed that real wages remained constant only for a rather short transition period which made it possible—with labour productivity increasing at a rate α owing to technical progress—to produce a definite increase in the rate of accumulation (see Chapter 4, section 5). The transition period being over, real wages once again begin to rise at a rate α accompanied by a more rapid increase in employment than was the case in the initial position. One might proceed in a somewhat different fashion by permitting real wages to increase over a long period at a rate lower than the rate of growth of productivity α. As a result, by the end of n years the ratio of national income to consumption would have been increased in the proportion $(1 + \alpha - \sigma)^n$ where σ is, of course, less than α.

It is clear that if this line is followed the Dobb–Sen approach recovers its significance to some extent. When the capital–output ratio is raised from k_0 to k, national income increases relative to consumption in the proportion $(1 + \alpha - \sigma)^n(1 + p)$. Equation (31) now takes the form

$$\frac{\dfrac{1}{1 - \pi_n'}}{\dfrac{1}{1 - i_0}} = (1 - p)(1 + \alpha - \sigma)^n$$

or

$$\pi_n' = 1 - \frac{1 - i_0}{1 + p}\frac{1}{(1 + \alpha - \sigma)^n} \qquad (32)$$

This result differs from formula (31) in that we now have $(1 + \alpha - \sigma)^n$ rather than $(1 + \alpha)^n$ in the denominator of the last term on the right-hand side of the equation. The present case is equivalent to the case examined above in which the rate of growth of productivity resulting from technical progress would be assumed $\alpha - \sigma$ rather than α. And it followed from the above that the lower the rate of growth of productivity α, the greater was the chance that raising the capital–output ratio with the reserve of labour in existence would prove a profitable proposition.

In Fig. 22 we draw the curve

$$\frac{1 - i_0}{(1 + p)(1 + \alpha - \sigma)^n}$$

along with the curves

$$\frac{1 - i_0}{1 + p} \quad \text{and} \quad \frac{1 - i_0}{(1 + p)(1 + \alpha)^n}$$

reproduced from Fig. 21. We assume that $\sigma = 1\%$, so that α having previously been fixed at 2.5%, we now have $\alpha - \sigma = 1.5\%$. It will be seen that, even with $\alpha - \sigma$ as low as this, the Dobb–Sen approach is of little significance. The diagram shows that the optimum solution, i.e. the slope of the straight line CP'', does not differ much from π_n, i.e. from the slope of the straight line CB''.

Our analysis seems to lead ultimately to the conclusion that the theory that economic growth should be accelerated by increasing the capital–output ratio has probably no major practical significance in the case where there exists a reserve of labour; however, the fact that the theory demonstrated a new aspect of the problem of choice of production techniques considerably increased the scope of the discussion of this subject.

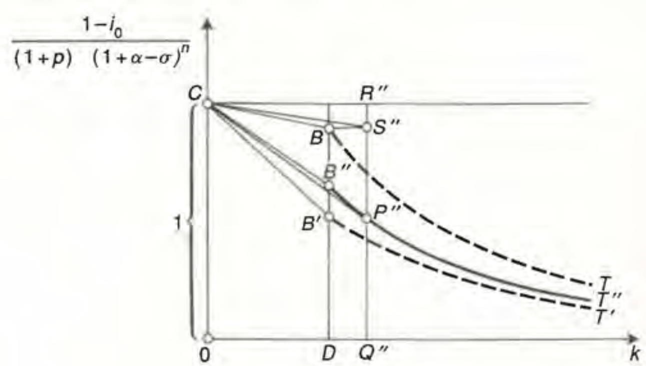

FIG. 22

5. In the above discussion we expressed some doubts as to the advisability of 'recasting' the stock of equipment in order to raise its capital intensity, given an unlimited reserve of labour (and neutral technical progress). However, we should still examine whether it is not advisable under such conditions to *reduce* the capital intensity of the stock of equipment. In this discussion we shall maintain Dobb and Sen's rule that real wages must not decline at any phase of the process involved. This already imposes some limitations upon the application of less capital- and more labour-intensive methods of production. But even more basic is the question of the physical possibility of reducing capital intensity in underdeveloped countries. Indeed, it should be kept in mind that in any branch of industry there is some minimum capital–output ratio which may be fairly high. Application of more primitive techniques may not be capable of reducing the capital intensity of production. It is difficult even to imagine primitive variants, for example, with regard to chemical processes. But even where such variants do exist they are not always less capital intensive. It appears, for instance, that the spinning-wheel is more capital intensive than modern spinning-machinery. On the other hand there do exist industries even in underdeveloped countries where it is possible to reduce the capital–output ratio by choosing methods which involve less investment and more labour, e.g. cotton-weaving, building, transport.

6. For the analysis of the influence of a reduction in m we shall use a diagram similar to Fig. 14. (For the present we shall ignore foreign-trade difficulties; these will be dealt with at a later stage.) As in that case we denote the capital–output ratio (in relation to fixed capital and inventories) in the initial position by k_0. But instead of discussing increasing the capital–output ratio we assume that it is possible to reduce it to some extent and hence that $k < k_0$. Thus to the same rate of productive accumulation there now corresponds a higher r (see Fig. 23).

In particular, to $i_0 = 0A$—the rate of productive accumulation which corresponded in the initial position to $\alpha + \beta$—there now corresponds the rate of growth $AE = \alpha + \beta + \gamma$. The increase in employment is based to the extent β on the natural increase in the labour force and to the extent γ on drawing on the labour reserve. $\beta + \gamma$ is not, however, the total rate of expansion of

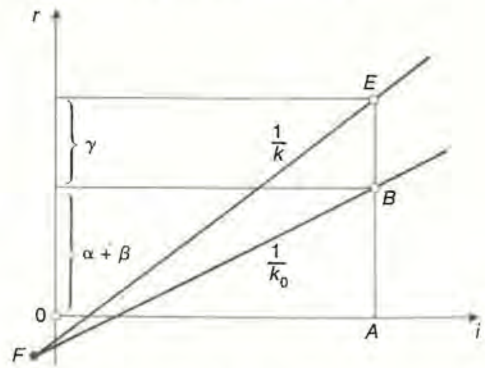

FIG. 23

employment. The initial rate of increase in productivity resulting from technical progress is α. It is obvious that after the reduction of the capital–output ratio from k_0 to k this rate cannot be maintained, since new equipment will be of a lower capital intensity than existing equipment with the capital–output ratio k_0, and will therefore also be characterized by correspondingly lower labour productivity. It follows that the annual rate of increase in productivity will be less than the rate α resulting from technical progress. However, as time goes by the situation will change. As the stock of equipment is gradually saturated with less capital-intensive techniques characterized by lower productivity, the rate of increase of average productivity will diverge less and less from α.

Finally when all the equipment is endowed with the new less capital-intensive technique, because all old equipment has been scrapped, the rate of increase in productivity will return to the level α.[31] (It is clear that this process is in a sense symmetrical with 'recasting' the stock of equipment with the aim of raising its capital intensity.)

The changes in national income, productivity, and equipment outlined above are illustrated by Fig. 24.

The ordinate is the rate of growth r, and the abscissa time t. The diagram shows how productivity and employment change in the course of 'recasting' which aims at a lower capital intensity. At the beginning of the process the rate of growth of average

[31] As already mentioned, throughout this chapter we assume neutral technical progress.

productivity is $\alpha - \delta$ where δ represents the effect of the first batch of equipment to be characterized by a lower capital intensity and a lower productivity of labour than the old equipment. This is compensated by an increase of δ in the rate of expansion of employment, in addition to β (the natural increase in the labour force) and γ (drawing on the labour reserve to increase the rate of growth of national income to $\alpha + \beta + \gamma$). Thus the total rate of growth of employment is $\beta + \delta + \gamma$, of which $\delta + \gamma$ depends on drawing on the labour reserve. As time goes by the deviation of the rate of increase in productivity from α declines, and after all the equipment has been endowed with a lower capital intensity and lower labour productivity this rate will go back to the level α. Thus the rate of increase in productivity rises from $\alpha - \delta$ at the beginning of the period to α at its end; conversely the rate of increase in employment declines from $\beta + \gamma + \delta$ to $\beta + \gamma$ (shaded area).

It is obvious that the acceleration of growth from $\alpha + \beta$ to $\alpha + \beta + \gamma$ without increasing the relative share of productive accumulation in the national income is feasible because of the unlimited supply of labour which makes it possible to raise the rate of increase in employment by $\delta + \gamma$ at the beginning of the period considered. It is this that explains the 'miracle' of being able to accelerate the growth of national income *and* consumption (the relative share of productive accumulation in the national income remaining unchanged). It should be noticed that there are two limitations to this rewarding operation. First, as mentioned above, the reduction in the capital–output ratio k has a limited scope because it is feasible only in some industries. Secondly, the reduction in k should not be pushed so far as to make δ higher than

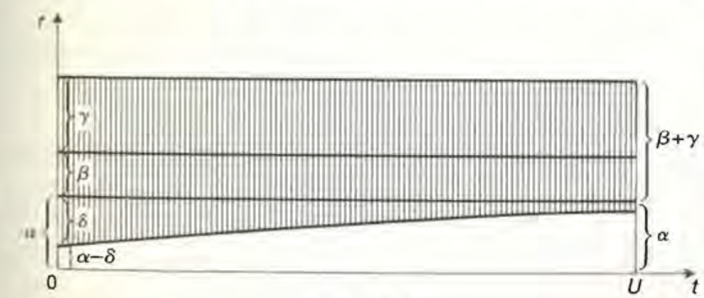

FIG. 24

α and thus $\alpha - \delta$ negative, since that would mean an *absolute decline* in labour productivity. This, however, would cause a fall in real wages which would violate the condition we set: indeed, consumption would increase *pari passu* with national income at a rate $\alpha + \beta + \gamma$, and employment at a higher rate, $\delta + \beta + \gamma$. (If $\delta < \alpha$ real wages would be growing but at a rate lower than α p.a.)

7. It is still interesting to consider what happens at the end of the period $0U$ if drawing upon the labour reserve in the course of that period has led to its exhaustion. In this case the rate of growth cannot be maintained at the level $\alpha + \beta + \gamma$ in the subsequent period and has to drop to $\alpha + \beta$, because no further drawing on the labour reserve is possible. If a higher rate of growth than this is desired, then it is necessary to reverse the process described by raising the capital–output ratio. This may appear paradoxical because having adjusted the equipment to a lower capital intensity, we now try to go back to our starting point. However, in the meantime surplus labour has been absorbed and national income and consumption increased at a high rate. Having achieved full employment we may either go back to the initial rate of growth or, if we desire a higher rate, we have to reverse the process and 'recast' equipment in order to increase its capital intensity because we no longer have the advantage of a labour reserve from which we benefited in the past.

The more capital-intensive technique is not *per se* either superior or inferior: the choice of the 'right' capital intensity depends on the availability of labour (allowing, as mentioned above, for technological limitations and maintenance of real wages).

8. Let us now take foreign-trade difficulties into consideration. We shall again use a diagrammatic presentation (see Fig. 25).

Imagine that after a reduction in the capital–output ratio from k_0 to k we then leave the rate of growth unchanged at $\alpha + \beta$. The relative share of productive accumulation in the national income would then decline to $0D$. Now if instead we had chosen to increase the rate of growth above that level this would have involved difficulties with foreign trade. As a result the relation between i and r is represented in Fig. 25 by the curve GH rather than by the straight line FE (cf. Fig. 6). If the curve GH is rather flat (as in the figure) the gain in the rate of growth will be small.

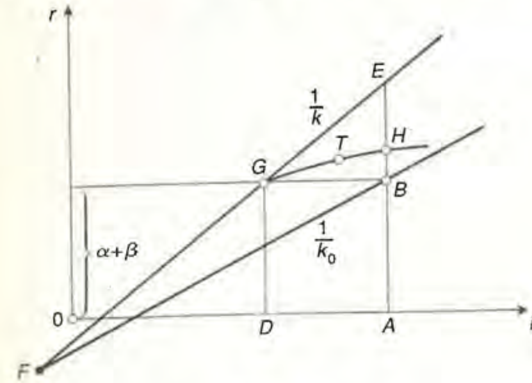

FIG. 25

In such a case it may be reasonable to leave the rate of growth at the level $\alpha + \beta$ rather than to increase it – thus gaining the advantage of a smaller relative share of productive accumulation in the national income. In this case by reducing the capital–output ratio from k_0 to k a higher relative share of consumption in the national income is achieved without impairing the rate of growth. This results in an immediate increase in the level of consumption without reducing its future rate of increase below $\alpha + \beta$. The changes in the rate of increase in productivity will be similar to those in the case previously considered. The rate of increase in employment will now fall from $\delta + \beta$ at the beginning of the period to β at its end (see Fig. 26).

The role of the labour reserve here is to make possible a compensation for the fall in the rate of increase in productivity (which amounts to $\alpha - \delta$ at the beginning of the period $0U$) by a correspondingly higher rate of increase in employment. The gain derived here from drawing upon the labour reserve is the higher relative share of consumption in the national income, which raises the *level* of consumption throughout the period considered while its rate of growth, as well as that of the national income, is unchanged at the level $\alpha + \beta$.

At the end of the period $0U$ drawing on the labour reserve will cease because the rate of increase in productivity will have returned to the level α. If by that time the labour reserve has been exhausted then, in contrast to the case previously considered, this will not affect the rate of growth at all since this is based solely

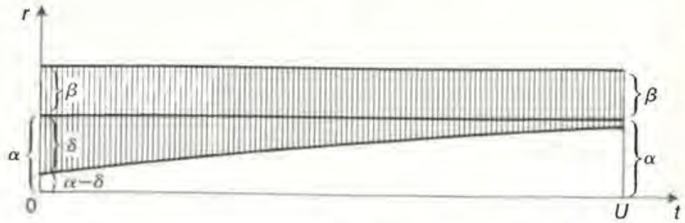

FIG. 26

on the increase in productivity resulting from technical progress (at a rate α) and on the natural increase in the labour force (at a rate β).

As may be seen, in the case presently considered the labour reserve permits a once-for-all increase in the standard of living rather than a higher rate of growth of consumption (*pari passu* with national income) over the period $0U$.

It is, of course, possible that the government will choose a variant which is intermediate between the two variants considered above, represented by point T on the curve GH lying between G and H (see Fig. 25). In such a case there will be an increase in both the rate of growth and the relative share of consumption in the national income over the period $0U$, for the ordinate of T is higher than $\alpha + \beta$ and its abscissa is lower than $i_0 = 0A$ (this means that the relative share of productive accumulation in the national income will be lower, and that of consumption higher, than in the basic position represented by point B). It is clear, however, that the increase in the rate of growth will be smaller than in the first variant and the rise in the relative share of consumption in the national income will be less pronounced than in the second.[6]

11. The Structure of Investment

1. So far we have laid the main stress in our discussion on changes in the relative share of productive accumulation (and in particular of productive investment) in the national income. In the case of uniform growth this share remains constant. It rises in the case of accelerated growth of national income, e.g. in the 'transition period' where the rate of growth is increased gradually with real wages remaining constant. Finally, when the rate of

growth decreases—as in the period of 'recasting' aimed at overcoming a labour shortage—the relative shares of productive accumulation and of productive investment in the national income decline. We shall now deal with the problem of changes in the structure of investment which result from such redistributions of the national income. More specifically, there arises the question, what part of total productive investment, I, is allocated in different cases to the investment sector itself, i.e. to the sector which produces productive equipment? We shall denote this part by I_i. To begin with, it is clear that with uniform growth the relative share of total investment devoted to the investment sector, i.e. I_i/I, remains constant. In such a case both total investment and national income increase at the same constant rate; stocks of capital equipment in the investment and non-investment[32] sectors bear a constant relation to each other and, as they grow at the same rate, the ratio between investment outlays in each of them must also remain constant.

Furthermore, the higher the rate of growth and thus—given the constancy of the parameters m, a, and u—the higher the relative share of investment in national income I/Y, the higher must also be the relative share of the investment sector in total investment I_i/I. For if both the investment and non-investment sectors are to expand at a constant rate, to a higher I/Y there must also correspond a higher proportion of total investment in the investment sector.

When I/Y is increased to a higher level—as happens in the 'transition period'—I_i/I must rise correspondingly. But *in the course* of such a process the proportion I_i/I must rise still more, since in this period the rate of growth of investment is higher than that of national income (the relative share of investment in the national income I/Y being raised) which means a more rapid expansion of the investment sector than of other sectors of production.

It should be noted that the above argument rests upon the assumption that equipment used for producing investment goods is qualitatively different from that used for producing other goods, and thus any increase in investment necessarily involves an

[32] This sector covers consumption in the broad sense and the increase in inventories.

expansion of the investment sector. This assumption is obviously not entirely realistic, as in many cases the same equipment can be used to produce goods for various end-uses and, in particular, changes in the relative share of investment in the national income can be effected to some extent through foreign trade. We shall return to this subject towards the end of the present chapter, but in the meantime we shall assume in our argument that no increase in investment is possible without an expansion of the productive capacity of the investment sector. In particular, we shall disregard foreign trade.

2. Before we enter into a more detailed discussion on the subject of the relative share of I_i in total investment I, we still have to say a few words about the capital–output ratio in the investment sector as compared with the corresponding ratio for the economy as a whole.

At the start of this essay we made the assumption that the capital–output ratio for total investment m did not depend upon the structure of investment. Strictly speaking this assumption can be satisfied only if the capital–output ratio in the investment sector is equal to the ratio in the non-investment sector. It will, however, also be approximately satisfied when the difference between the ratios for both sectors (including production of the respective raw materials) is not very large, and such is in fact the case.[33] As will be seen below, under such conditions even rather sizeable changes in the structure of investment affect m only slightly.

The relationship between m for the economy as a whole, m_i for the investment sector, and m_c for the remainder of the economy is as follows

$$\frac{1}{m} I = \frac{1}{m_i} I_i + \frac{1}{m_c} (I - I_i)$$

where I_i denotes, as above, investment in the investment sector. Dividing both sides of the equation by total investment I we obtain

$$\frac{1}{m} = \frac{1}{m_i} \frac{I_i}{I} + \frac{1}{m_c} \frac{I - I_i}{I}$$

[33] In contrast, primary production is generally characterized by a much higher capital–output ratio than manufacturing.

Let us assume $m_i = 3$ and $m_c = 2$; then, for $I_i/I = 0.1$ we obtain $m = 2.1$ and for $I_i/I = 0.5$ we obtain $m = 2.4$. The results of our subsequent argument will not be significantly affected if we assume that m remains constant at the level of 2.25.

We shall thus assume below that m is sufficiently stable to permit us to disregard changes resulting from shifts in the structure of investment.[34] At the same time, however, we shall take into account the difference between the capital–output ratio in the investment sector m_i and the overall ratio m, this difference being a significant factor in the distribution of investment between the investment and non-investment sector.

3. We shall now examine in detail the changes in I_i/I which result from changes in the level of I/Y. Let us begin by recalling equation (3) which shows the relationship between the rate of growth of national income and the relative share of productive investment in the national income

$$r = \frac{1}{m} \frac{I}{Y} - (a - u)$$

Let us now denote by r_i the rate of growth of productive investment. We may write an equation similar to (3) for the investment sector alone. If we include in this sector the output of all raw materials which are used in the production of investment goods the income produced in this sector is equal to I.[35] Productive investment in this sector was denoted above by I_i; assuming for the sake of simplicity that a and u for this sector are the same as for the economy as a whole, we may write

$$r_i = \frac{1}{m_i} \frac{I_i}{I} - (a - u) \tag{33}$$

We now subtract equation (3) from equation (33)

$$r_i - r = \frac{1}{m_i} \frac{I_i}{I} - \frac{1}{m} \frac{I}{Y}$$

Hence we obtain the formula

$$\frac{I_i}{I} = \frac{m_i}{m} \frac{I}{Y} + m_i(r_i - r) \tag{34}$$

[34] With the exception of one extreme case which is considered towards the end of the present chapter.
[35] As noted above we disregard foreign trade for the time being.

which we shall apply to the examination of changes in I_i/I in different circumstances.

In the case of uniform growth both r and I/Y are constant. Since the latter is constant, I grows at the same rate as Y (i.e. at the rate r) which means that $r_i = r$. Therefore, according to equation (34), in this case we have

$$\frac{I_i}{I} = \frac{m_i}{m}\frac{I}{Y} \tag{35}$$

It follows that I_i/I is constant, as is I/Y. Moreover, to a greater relative share of investment in the national income there corresponds a proportionately higher relative share of the investment sector in total investment I_i/I. If the capital–output ratio in the investment sector m_i is equal to the overall capital–output ratio m, we have

$$\frac{I_i}{I} = \frac{I}{Y}$$

Let us now consider the case of accelerating growth where both r and I/Y are increasing. The increase in the latter means that investment grows more rapidly than national income, i.e. $r_i > r$. From this and from equation (34) it follows that

$$\frac{I_i}{I} > \frac{m_i}{m}\frac{I}{Y} \tag{36}$$

Thus the relative share of the investment sector in total investment corresponding to a given level of I/Y is greater here than it would be in the case of uniform growth (this will be seen by comparing formulae (35) and (36)). For the special case when $m_i = m$ we have the inequality

$$\frac{I_i}{I} > \frac{I}{Y}$$

Let us suppose that in the initial position the economy is subject to uniform growth. We have, then, the relationship

$$\frac{I_{i,0}}{I_0} = \frac{m_i}{m}\frac{I_0}{Y_0} \tag{37}$$

where Y_0, I_0, and $I_{i,0}$ are, respectively, the national income, productive investment, and investment in the investment sector, at

the point of departure of the accelerated growth. After a period of τ years of such growth we enter a new period of uniform growth, but with a higher rate of growth of national income (cf. Chapter 4, section 5). Let us write Y_τ, I_τ, $I_{i,\tau}$ for national income, productive investment, and investment in the investment sector, at the beginning of the new period of uniform growth. Again we have the relationship

$$\frac{I_{i,\tau}}{I_\tau} = \frac{m_i}{m}\frac{I_\tau}{Y_\tau} \tag{38}$$

Evidently, I_τ/Y_τ is higher than the corresponding ratio in the initial position corresponding to the higher r. As will be seen from formula (38), the ratio $I_{i,\tau}/I_\tau$ is proportionately higher as well. But *during* the period of acceleration the relationship between I_i/I and I/Y will be different, for at time t it follows from formula (34) that

$$\frac{I_{i,t}}{I_t} = \frac{m_i}{m}\frac{I_t}{Y_t} + m_i(r_{i,t} - r_t)$$

where $I_{i,t}$, I_t, Y_t, $r_{i,t}$, and r_t are respectively investment in the investment sector, total investment, national income, and the rates of growth of investment and of national income—all at time t within the transition period $(0 < t < \tau)$.

From the above equation we subtract equation (37) and thus obtain

$$\frac{I_{i,t}}{I_t} - \frac{I_{i,0}}{I_0} = \frac{m_i}{m}\left(\frac{I_t}{Y_t} - \frac{I_0}{Y_0}\right) + m_i(r_{i,t} - r_t)$$

Consequently the increase in I_i/I from the beginning of the transition period to time t depends not only on a corresponding increase in I/Y but also on the difference between the rates of growth of investment and national income. This growth of I_i/I reflects the fact that the fixed capital in the investment sector is expanded more rapidly than that in the remainder of the economy.

When the transition period is over and a new period of uniform growth begins, the term $m_i(r_{i,t} - r_t)$ obviously disappears so that at time τ we have

$$\frac{I_{i,\tau}}{I_\tau} - \frac{I_{i,0}}{I_0} = \frac{m_i}{m}\left(\frac{I_\tau}{Y_\tau} - \frac{I_0}{Y_0}\right)$$

which also follows directly from formulae (37) and (38).

When growth is slowed down—as, for example, in a period of 'recasting' aimed at overcoming the shortage of labour—the situation is reversed: I_i/I is smaller than $(m_i/m)(I/Y)$ in the period of slowing down of growth.

4. It may be shown on the basis of formula (34) that there exists a ceiling to the deviation of the rate of growth of investment from that of national income which is determined by the productive capacity of the investment sector. The greater this deviation, the greater must be the relative share of the investment sector in total investment, i.e. I_i/I. This share, however, cannot exceed unity since *gross* investment in the non-investment sector cannot become negative. Assuming $I_i/I = 1$ we obtain from formula (34) the following expression for the case where $r_i - r$ reaches a maximum

$$1 = \frac{m_i}{m}\frac{I}{Y} + m_i(r_i - r)$$

This formula, however, is not quite correct. As a first approximation we based our argument in this chapter on a constant m which, however, differed from m_i. But in the extreme case presently considered m becomes equal to m_i since total investment is concentrated in the investment sector. Accordingly, we can make our formula more precise by substituting m_i for m; we thus obtain

$$1 = \frac{Y}{I} + m_i(r_i - r)$$

or

$$r_i - r = \frac{1}{m_i}\left(1 - \frac{I}{Y}\right) \tag{39}$$

If we assume $m_i = 3$ and $I/Y \geqslant 0.2$, the maximum possible value of $r_i - r$ will be less than $(1 - 0.2)/3$, or less than 26.5%.[36]

It follows that when a decision is being taken on the acceleration of the growth of national income, it must be ascertained that the ceiling to the difference between the rate of growth of investment and that of national income is not exceeded in the course of this acceleration, i.e. in the 'transition period'. In fact this is rather unlikely to be the case under our assumption of constancy of real wages which is tantamount to consumption rising *pari passu* with employment in the 'transition period'. When the ceiling of $r_i - r$ is reached all investment will be concentrated in the investment sector and the production of the non-investment sector will change at a rate $u - a$. Thus in order to maintain real wages u would have to be rather high. If, however, such a situation does arise, $r_i - r$ must be reduced by slowing down the acceleration of growth and thus lengthening the 'transition period'. This could be accomplished by permitting real wages to increase somewhat, instead of keeping them stable (of course, their growth would have to be less rapid than that of labour productivity resulting from technical progress).

[36] If we use formula (34) without modification and assume $m = 2.25$ we obtain 24.5% for the maximum of $r_i - r$.

5. So far we have ignored the possibility of increasing investment either by changing the way in which some equipment is used, or through foreign trade, e.g. the possibility of turning plant used in the manufacture of consumer durables to production of machinery, or increasing imports of machinery at the expense of either cutting down imports of consumer goods or increasing exports of these goods. Hence the only way of increasing the relative share of investment in the national income was to make the investment sector expand more rapidly than total productive capacity. Now we shall also take into account the possibility of changes in the use made of this capacity, and in the structure of foreign trade.

So far the rate of growth of investment has been determined by the formula

$$r_i = \frac{1}{m_i}\frac{I_i}{I} - (a - u) \tag{33}$$

which is equivalent to

$$\Delta I = \frac{1}{m_i} I_i - aI + uI \tag{33'}$$

The increment of investment ΔI thus depends on: the productive effect of investment I_i in the investment sector; the contraction of income aI produced in this sector as a result of obsolescence and wear and tear of equipment; and the increase in income uI resulting from improvements in the utilization of equipment.[37]

[37] As we are no longer ignoring foreign trade, it follows that, to make the part of national income produced in the investment sector equal to the value of

This formula is no longer adequate for the problem. Suppose investment is to grow more rapidly than national income, i.e. that $r_i I > rI$. The expression $r_i I - rI$ represents the part of the increment in investment which is responsible for the increase in the relative share of investment in the national income. It must now be taken into account that part of $r_i I - rI$ results from the change in the use made of capital equipment, or in the structure of foreign trade. Let us suppose that this change is $d(r_i - r)I$ where d is a coefficient $\leqslant 1$. Instead of formula (33) we may now write

$$\Delta I = \frac{1}{m_i} I_i - (a-u)I + d(r_i - r)I$$

or, dividing both sides by I,

$$\frac{\Delta I}{I} = r_i = \frac{1}{m_i}\frac{I_i}{I} - (a-u) + d(r_i - r) \tag{40}$$

When $r_i = r$ the additional term on the right-hand side of the equation disappears; this is as it should be since $r_i = r$ means that the economy is expanding at a constant rate r and no change in the rate of investment is needed on account of changes in the use made of capital equipment or in the structure of foreign trade.

If the equation

$$r = \frac{1}{m}\frac{I}{Y} - (a-u) \tag{3}$$

is deducted from equation (40) we obtain

$$r_i - r = \frac{1}{m_i} \cdot \frac{I_i}{I} - \frac{1}{m}\frac{I}{Y} + d(r_i - r)$$

$$\frac{I_i}{I} = \frac{m_i}{m} \cdot \frac{I}{Y} + m_i(1-d)(r_i - r) \tag{41}$$

This equation corresponds to equation (34) while differing from it in that the coefficient of $r_i - r$ has now been reduced from m_i to $m_i(1-d)$. This means that the relative share of investment in the investment sector in total investment I corresponding to a given difference $r_i - r$ is now smaller, because a faster expansion

investment I, we must include in this sector that part of total production for export which covers payment for imports both of raw materials for the investment sector and of finished investment goods (machinery, etc.).

of the investment sector is no longer the only method used to increase the relative share of investment in the national income when the growth of the latter is to be accelerated.

However, in the case of uniform growth, when $r_i = r$, we have the old formula (35)

$$\frac{I_i}{I} = \frac{m_i}{m}\frac{I}{Y}$$

because in this case there is no question of increasing the share of investment in the national income.

Finally, for the ceiling value of $r_i - r$ which is reached in the situation when $I_i = I$ and $m = m_i$, we obtain from formula (41) the equation

$$r_i - r = \frac{1}{m_i(1-d)}\left(1 - \frac{I}{Y}\right) \tag{42}$$

which, again, differs from formula (39) in that the term $m_i(1-d)$ replaces m_i in the denominator of the right-hand side of the equation. As a result, the ceiling for $r_i - r$ now becomes higher than it was in the former case. This results from the fact that the limiting influence of the productive capacity of the investment sector on the difference between r_i and r is now relaxed; the more rapid increase in investment than that in the national income is partly achieved by changes in favour of investment in the use of equipment and in the structure of foreign trade.

APPENDIX:
The Production Curve and the Evaluation of the Efficiency of Investment in a Socialist Economy[7]

1. The concept of the production curve is based on the assumption of an equal life-span for all types of equipment, since only in such a case can a variant for producing a given increment of national income be fully characterized by the investment outlay and the labour force associated with it (the third characteristic being the life-span of equipment). But even taking this assumption for granted the approach to the production curve developed in Chapter 7, section 2 may be questioned (cf. n. 13 above). For the central planning authorities are obviously unable to consider the enormous number of possible variants capable of producing an increment in the national income in order to eliminate those which are absolutely inferior, i.e. for which the investment outlays are greater and the labour force not less than in some other variant or vice versa. Thus the production curve appears to be purely theoretical in character since its points are not necessarily realized in practice, i.e. one cannot exclude the possibility that a definitely inefficient variant may be selected. We shall, however, show that this problem does not arise if the evaluation of the efficiency of investment for any type of commodity is based on the criterion

$$\frac{j}{T} + w = \text{minimum}$$

Where j is total investment outlay taken over all stages of production, w total current costs (exclusive of depreciation), and T the so-called recoupment period. Indeed, we shall prove that to a given T there corresponds a point on the production curve. It should be pointed out that on the assumption of an equal life-span for all types of equipment the simple condition

$$\frac{j}{T} + w = \text{minimum}$$

is an appropriate criterion for the choice of variants.

We shall assume that in the case where the 'joint investment and labour outlay' $j/T + w$ is equal for two variants the less capital intensive one is chosen, i.e. that with a smaller j.

We denote by j_c and w_c the investment outlay and costs of the variant of production chosen for a given type of commodity and by j and w

these parameters for any variant for this type of commodity. We then have

$$\frac{j_c}{T} + w_c \leqslant \frac{j}{T} + w$$

By adding these inequalities for the economy as a whole we obtain

$$\sum\left(\frac{j_c}{T} + w_c\right) \leqslant \sum\left(\frac{j}{T} + w\right)$$

$$\frac{1}{T}\sum j_c + \sum w_c \leqslant \frac{1}{T}\sum j + \sum w \tag{43}$$

Σj_c and Σw_c however, are the aggregate investment outlay J_c, and aggregate costs W_c required for a given increase in national income using the methods actually adopted, while Σj and Σw are the aggregate values J and W for any other variant. We thus have

$$\frac{J_c}{T} + W_c \leqslant \frac{J}{T} + W \tag{43'}$$

It follows directly that the point J_c, W_c cannot correspond to an absolutely inferior variant. Indeed, if J_c were, for instance, greater than J' for some other variant, and W_c were no less than W', we could write

$$\frac{J'}{T} + W' < \frac{J_c}{T} + W_c$$

which would contradict inequality (43′).

Let us now denote the hourly wage for unskilled labour by h. To aggregate costs W_c there corresponds a labour force expressed in terms of unskilled labour $L_c = W_c/h$. It follows from the above that the point J_c, L_c is situated on the production curve because the latter represents all the 'efficient' variants for producing a given increase in national income, i.e. the variants which are not absolutely inferior.

J_c, L_c is a point on the production curve corresponding to a given period of recoupment T; it will be noticed that the greater is T, the further to the right on the production curve is the corresponding point J_c, L_c because a higher recoupment period 'lets in' more capital-intensive and less labour-intensive variants for particular types of commodity. However, we shall not be satisfied with this rather intuitive argument, but shall prove the theorem rigorously and at the same time demonstrate that the production curve is concave.

2. Let us start with a diagrammatic representation of the variants of production for a given type of commodity, plotting investment outlays j as the abscissa, and the current costs w as the ordinate (Fig. 27).

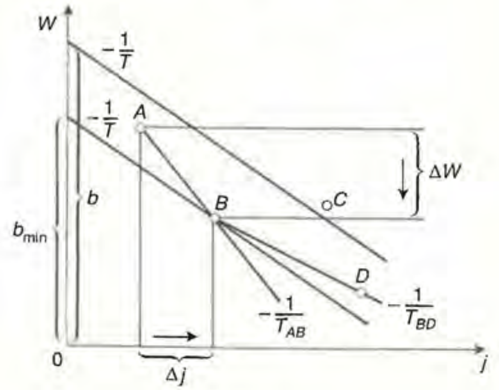

FIG. 27

If the recoupment period is T, it can be shown that the best variant will be on the lowest possible straight line of slope $-1/T$. The equation for the straight line with such a slope is

$$w = -\frac{j}{T} + b$$

where b is the distance from the origin of the point of intersection of this straight line with the j-axis. Thus

$$\frac{j}{T} + w = b$$

and the condition for the best variant is

$$\frac{j}{T} + w = b_{\min}$$

It follows directly that a point j, w must be chosen through which there passes the straight line with the lowest b. It also follows that at no T is point C considered, and there remain only A, B, D on the lower concave boundary from which to choose. Let us now denote the recoupment periods corresponding to the slopes AB and BD by T_{AB} and T_{BD}. If $T = T_{AB}$ we shall choose variant A; indeed for variants A and B the value of the expression $j/T + w$ is the same and according to our rule we then choose the less capital-intensive variant. If $T_{AB} < T \leqslant T_{BD}$ we choose variant B (the case represented in Fig. 27). Finally, when $T > T_{BD}$, variant D will prove the best. In other words if when increasing the recoupment period T we exceed the level T_{AB}, we shift from the variant A to a more capital-intensive and less labour-intensive variant B. (If we exceed T_{BD} we shift correspondingly from variant B to variant D.)

3. Let us now consider all the types of commodity for which we may draw diagrams similar to Fig. 27. Let us derive from each diagram the recoupment periods T corresponding to the segments of the lower concave boundary such as T_{AB} and T_{BD}. Let us range all these recoupment periods according to their length; we shall obtain an increasing sequence

$$T_1, T_2, \ldots, T_{s+1}, \ldots, T_m$$

It should be noted that T_s may correspond to a number of types of commodity and that T_{s+1} may obviously correspond to different types of commodity from T_s.

Let us imagine that a recoupment period T_s has been adopted corresponding to the point J_s, L_s on the production curve and that we next pass from T_s to T_{s+1}. Then for types of commodity to which T_s corresponds, this level of the recoupment period will be exceeded (for instance T_{AB} on Fig. 27) and, according to the above, a shift will occur for these commodities to more capital- and less labour-intensive variants (for instance from variant A to variant B). As a result the value of the investment outlay in the economy as a whole will also increase from J_s to the higher level J_{s+1} and the labour force required will fall from L_s to L_{s+1}. The point J_{s+1}, L_{s+1} on the curve of production corresponding to T_{s+1}, will therefore be situated to the right of and below the point J_s, L_s which corresponds to T_s (see Fig. 28).

Nor is this all, for T_s corresponds to a segment of the lower boundary of the set of points representing the variants on one or more diagrams relating to particular types of commodity (for instance AB in Fig. 27). When T_s is exceeded a shift occurs from the left-hand end of this segment to the right-hand end (e.g. from A to B). Thus the respective increases in current costs Δw and investment Δj are in the ratio $-1/T_s$ (e.g. $-1/T_{AB}$), i.e.

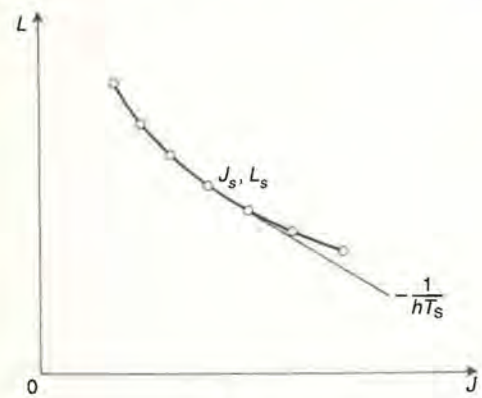

FIG. 28

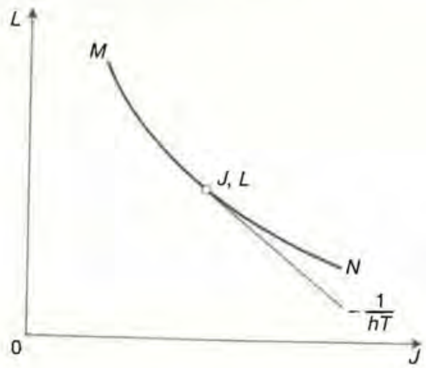

FIG. 29

$$\Delta w = -\frac{1}{T_s}\Delta j$$

Since the sum of these increases constitutes the increment in aggregate investment outlay and aggregate costs, we obtain

$$W_{s+1} - W_s = -\frac{1}{T_s}(J_{s+1} - J_s)$$

and thus

$$L_{s+1} - L_s = -\frac{1}{hT_s}(J_{s+1} - J_s) \tag{44}$$

It follows directly that the straight line connecting the subsequent points J_s, L_s and J_{s+1}, L_{s+1} situated on the curve of production has a slope $-1/h\,T_s$. In other words the segment starting from the point J_s, L_s has the slope $-1/h\,T_s$ (Fig. 28). Consequently, the greater the recoupment period T_s the further to the right is situated the corresponding point J_s, L_s (which has already been proved above) and the smaller the slope of the segment starting from this point. This means, however, that the line represented on Fig. 28 is concave.

If the points J_s, L_s are sufficiently close to each other this line approaches the production curve and the slopes of its segments—those of the tangents at these points. The tangent of the production curve at the point J, L is consequently equal to $-1/h\,T$ and thus it is easy to read from the diagram the recoupment period corresponding to a given point (see Fig. 29). Because J increases together with T, the production curve is concave.

Theories of Growth in Different Social Systems[1] (1970)

1. The paper purports to develop the idea that the institutional framework of a social system is a basic element of its economic dynamics and thus of the theory of growth relevant to that system. The idea sounds plausible but nevertheless there is a tendency in Western economics—which shows at present a considerable interest in the theory of economic growth—to deal with something like a *general* theory of growth working on models fairly remote from the realities of the present capitalist, socialist, or 'mixed' economies. Actually the writings in question usually relate (at least by implication) to some sort of idealized *laisser-faire* capitalism. Their problems and results are easily translatable into the categories of a socialist system and, what is of interest, they fit in better here than with capitalism but not quite well still, for they concentrate frequently on points which do not happen to be most essential. There thus arises a situation which is not infrequent in the history of economic thought: theories are being created which may raise problems of great interest but are not very conducive to understanding what actually happened, is happening, or should be happening.

2. To my mind the central problem of the *laisser-faire* capitalist system to which apply the theories referred to above is that of effective demand, i.e. that of finding markets for its products at full utilization of resources. It is also this problem that in the 1950s was still generally in the centre of interest of Western economists in connection with the theory of cyclical fluctuations and with the problem of government intervention to counteract them.

But from the time the discussion of economic dynamics has concentrated on problems of *growth* the factor of effective demand was generally disregarded. Either it was simply *assumed* that in the long run the problem of effective demand does not matter because apart from the business cycle it need not to be taken into consideration; or more specifically the problem was approached in two alternative fashions: (i) The growth is at an equilibrium (Harrodian) rate, so that the increase in investment is just sufficient to generate effective demand matching the new productive capacities which the level of investment creates. (ii) Whatever the rate of growth the productive resources are fully utilized because of long-run price flexibility: prices are pushed in the long run in relation to wages up to the point where the real income of labour (and thus its consumption) is enough to cause the absorption of the full employment national product.

I do not believe, however, in justifying the neglect of the problem of finding markets for the national product at full utilization of resources either in fashion (i) or (ii). It is generally known that the trend represented by the case (i) is unstable: any small fortuitous decline in the rate of growth involves a reduction of investment, and in consequence of the national income, in relation to the stock of equipment, which affects investment adversely and induces a further fall in the rate of growth. The belief that such disturbance creates merely a downswing followed by an upswing in relation to the growth proceeding at an equilibrium rate, i.e. that it yields a trend *cum* business cycle is mathematically indefensible: the underlying equations are incapable of producing a solution corresponding to a combination of an exponential curve with a sine line.[2] Nor do I subscribe to the long-run price flexibility underlying theories of the type (ii). The monopolistic and semi-monopolistic factors involved in fixing prices—deeply rooted in the capitalist system of all times—cannot be characterized as temporary short-period price rigidities but affect the relation of prices and wage costs both in the course of the business cycle and in the long run.

3. To my mind the problem of the long-run growth in a *laisser-faire* capitalist economy should be approached in precisely the same fashion as that of the business cycle. The 'pure' business cycle is a special case of the general phenomenon of trend *cum* business cycle where the rate of growth is equal to zero, i.e. where the economy is stationary. In the argument on which the theories of the business cycle were based certain quantities were assumed constant—this was partly linked with inadequate accounting for technical progress—which in an expanding economy must certainly grow. Thus it is necessary to deal with this limitation (which ties down the theory of the business cycle to a stationary economy) and arrive at a movement of the system comprising both the trend and cyclical fluctuations. Or to put it somewhat differently: the central problem of the dynamics of the *laisser-faire* capitalist system is to show what makes the system expand if the solutions on the lines (i) and (ii) are discarded as inadequate. Indeed, the mere fact that capital accumulation creating new production potentialities is *feasible* does not prove yet that this investment will be forthcoming and the new production potentialities will be adequately used.

There may arise a question at this point whether this problem is still of interest in the world of today in which the *laisser-faire* capitalist system is dead because of widespread government intervention. I still believe that the enquiry into dynamics of a *laisser-faire* system is of importance both in connection with economic history, even fairly recent one, and because the present state of capitalist economies is an offshoot of a somewhat chaotic interplay between the *laisser-faire* tendencies and of government action.

In any case these complicated phenomena cannot be adequately portrayed by models of *laisser-faire* economies referred to above in which the problems of effective demand and of utilization of resources are neglected. There *is* probably some interconnection between government intervention and these models but rather psychological in character: the high level of employment creates a climate favourable to their construction being unperturbed by the problem of effective demand.

4. As already mentioned in section 1 the models of growth developed in Western economies are related explicitely to some sort of idealized *laisser-faire* capitalist economies with the implication, however, that the problems tackled are so general in character that with slight modifications the results are relevant to problems of a socialist system. This is perfectly true: indeed they do apply to socialist economies where the problem of effective demand is really solved in the way (ii) of section 2: prices are fixed by *planning authorities* in relation to wages in such a way as to achieve full utilization of resources (and this is true not only in the long run but even in a short period).

The trouble, however, arises out of the fact that the models to which we refer do not concentrate frequently on essential problems rooted in the realities of socialist economies. Two points of this character are worth emphasizing as examples.

i. Most of the studies on long-run economic growth are written in terms of 'comparative statics'. For instance, the problem of what capital–output ratio secures in a uniformly expanding system the highest real wage, while full employment is maintained, may be of small practical importance; for if the initial capital–output ratio is less, the 'retooling' of the stock of capital in order to achieve this paradise means a long period of higher investment, in the early part of which the real wage would fare *worse* than if no change in the capital–output ratio were attempted. We have here a typical case of 'sacrificing the present for the future' which I believe to be a political problem of first rank in the socialist economy. But the basis for political decisions on problems of this nature is a thorough economic enquiry into the *transition* from one curve of growth to another.

ii. Nowhere in Western models discussed here appears the problem of 'long-run development bottlenecks'. When national income grows at a high rate the expansion of certain industries lags behind that of demand for their products because of certain organizational or technological factors, for instance shortage of appropriately trained personnel or difficulties in adaptation of technical improvements (the latter is especially the case in agriculture). The resulting gaps have then to be made good by foreign trade and to maintain the balance of the latter either some exports have to be increased or some imports replaced by home production. These operations will be usually accompanied by higher outlays of capital and labour and in this way affect profoundly the problems of economic growth.

The contradiction between consumption in the short period and in the long run and the long-run bottlenecks, appearing under the guise of the difficulties in balancing foreign trade, are in fact the central problems of a realistic theory of growth in a socialist economy.

5. As observed at the end of section 3 the models of *laisser-faire* capitalist economies which do not deal adequately with the problems of effective demand and utilization of resources are not a substitute for an enquiry into the effects of government intervention aimed at tackling these problems. Nevertheless the literature on this crucial subject of contemporary capitalism is astonishingly scarce. Perhaps there exists here a rather perverse division of labour: the government acts to achieve a high utilization of resources and the economists take this state as the point of departure in their discussion without mentioning who is responsible for it. There is, however, one exception to the rule: much space is being devoted to the theory of economic development of 'mixed' underdeveloped economies. By the way, the problem of *deficiency* of effective demand does not arise here, for government investment is large in relation to the productive potential which is very low despite abundance of labour. As a result the situation is characterized by inflationary pressures on scarce supply of necessities rather than by inadequate effective demand, even though disguised and also open unemployment is in existence.

It seems to me that the central problem here is at whose expense the country is to be developed. If inflationary pressures on scarce supplies of necessities, especially of food persist, it is the broad poverty-stricken masses of the population that bear the burden of high investment. If this is to avoided, the rate of growth of supply of necessities must be kept in line with the rate of growth of the national income. And to make room for investment, consumption of non-essentials out of higher incomes must be restrained by an appropriate fiscal policy. This, however, makes the 'non-inflationary' rate of growth dependent on agrarian conditions because they determine to a great extent the feasible progress of agriculture and thus of supply of necessities. The main part of 'financing' investment is played in this context by the ability to grow food faster. This must be supported none the less by financial measures in the strict sense aiming at restraining the increase in consumption of non-essentials.

As in a socialist economy, the problem of saving present for future consumption is involved here. But the contradiction is less acute, the 'sacrificed' consumption being of the rich and the well-to-do. This possibility, however, is too good to be true. In fact agrarian conditions prevailing in most of these countries (dependence of the peasant on the landlord, the merchant or the money lender) permit the supply of food to expand only slowly.

As a result the 'non-inflationary' rate of growth of national income is rather low. But if it *is* fairly high, inflationary pressures are rampant and no relative shift in composition of consumption to the advantage of necessities, as described above, takes place.

6. We shall now illustrate the fact discussed above at some length—that to each social system there corresponds an appropriate theory of growth by showing that the same formula for the rate of growth of national income should be interpreted in a different fashion depending on the social system we deal with.

Let us denote the level of real national income in a given year by Y and the increment of that income from the beginning to the end of the year by ΔY. The latter will consist of three elements: (i) the productive effect of gross investment $1/m\ I$ where m is the so-called capital–output ratio and I the level of gross investment (i.e. before deduction of depreciation); (ii) the negative effect of the shrinkage of productive capacity as a result of scrapping of obsolete equipment, $-aY$; and (iii) the increase of national income due to better utilization of the existing productive capacities as a result of organizational improvements, uY. We thus obtain

$$\Delta Y = \frac{1}{m} I - aY + uY$$

or

$$r = \frac{\Delta Y}{Y} = \frac{1}{m}\frac{1}{Y} - a + u$$

where r is the rate of growth of national income.

In a socialist economy all three coefficients m, a, and u are determined, so to say, on the supply side: m and a depend on the decision of planning authorities as to technique of production (capital intensity of new production and policy of scrapping obsolete equipment); u represents the rate of growth of utilization of existing equipment as a result of organizational progress.

The formula will remain entirely correct in a *laisser-faire* capitalist economy but the interpretation of the coefficients is quite different. The rate of change in the degree of utilization of existing equipment u depends on effective demand and in the business cycle it will even change its sign. But even if we take the long-run view, u is still determined, at least in part, on the demand side if we do not believe in the long-run flexibility of prices (cf. section

2). Even in m there may be demand elements: it is true that the new and thus most modern equipment is likely to work to capacity but some under-utilization of equipment because of lack of effective demand is not fully excluded even in this case.

In the case of a 'mixed' economy where the rate of increase of supply of necessities is too low in relation to the rate of growth of the national income a different problem will arise in interpretation. The coefficients m and u may have the same meaning as in the case of a socialist economy but the division of consumption as between necessities and non-essentials may signify inflationary pressures and the resulting redistribution of income to the advantage of higher-income groups.

We see again here that the theory of growth of a social system of a certain type should reflect its crucial problems.

PART 2

EFFICIENCY OF INVESTMENT

Generalized Formula of the Efficiency of Investment[1]

(*with M. Rakowski*)

(1959)

Polish and Soviet discussions on methods of calculating the efficiency of investment have shown that some of the greatest difficulties are confronted here in connection with such problems as the 'freeze' of investment resources during the construction period, the different durabilities of plant, and the uneven distribution of output and costs over time.

In particular the formula for determination of the efficiency of investment suggested at the June 1959 symposium was rightly criticized for inadequate treatment of these problems.

On the other hand, the suggestions (made at the symposium) to discount investment outlay, outputs, and current costs at a rate equal to the average rate of growth of the economy do not solve the problem. They have no theoretical justification; moreover, they dissociate the problem of the reduction of current costs through higher capital outlays from that of the balance of the labour force.

The present paper summarizes the results of a further methodological enquiry into the subject. The basic principle adopted is that two investment variants A and B are equally effective if investing by method A or B yields the same final effect in the development of the economy while preserving the equilibrium in the labour-force balance.

1. The Simplest Form of the Formula for Efficiency of Investment

Let us consider first a highly simplified model of a national economy in which all the plant is built 'instantaneously' and thus the problem of the 'freeze' of investment resources during the period of construction is avoided. Moreover, let all the plant constructed have the same durability, say of twenty years; we can therefore eliminate the issue of different life-spans of plant operation. Finally, to eliminate from our model the problem of uneven distribution of output and costs over time let us assume that they are constant. Thus, the only remaining problem in this simplified model is the amount of additional investment outlays ΔI, which one is prepared to make in order to reduce the current costs by ΔK or the problem of the upper limit to the recoupment period T. As has been pointed out[1] the value T should be chosen so as to maximize the increment in the national income corresponding to a given level of investment. There are numerous possibilities in the Polish economy of cost reduction through replacement or modernization of old equipment or mechanization of single processes at the expense of a moderate investment outlay with the recoupment period of certainly less then six years. Hence reduction of costs at the expense of initial investment outlay with a longer recoupment period would be wasteful. The condition for the choice of the more capital-intensive alternative of the two variants yielding the same output may now be represented as

$$I_2 - I_1 \leqslant (K_1 - K_2)T$$

or

$$\frac{I_2}{T} + K_2 \leqslant \frac{I_1}{T} + K_1$$

In other words, of the two alternatives the more favourable is that with a lower value of

$$E = \frac{I\frac{1}{T} + K}{P} \tag{1}$$

This is equivalent to the hitherto used

$$\frac{I + Iqn + Kn}{Pn}$$

where $q = 1/T - 1/n$. However, whereas this expression was considered valid for any life-span of the plant n, expression (1) assumes a standard period n_s (say twenty years). For periods other

[1] See e.g. M. Rakowski, 'Maksymalizacja wzrostu gospodarczego a oprocentowanie nakładów' (Interest on Investment Outlay and Maximizing of Economic Growth), *Gospodarka Planowa*, 14/10 (1959).

than the standard one the expression requires modifications discussed in section 3 of this paper.

2. Influence of the 'Freeze' of Investment Outlay in the Course of Construction

The fact that construction of plant takes appreciable time with a resulting 'freeze' of investment resources has an influence upon the efficiency of investment. It is evident that this influence is proportionate to the magnitude of the 'freeze' of the funds in the course of construction, i.e. to

$$\sum_0^{t_b} i_t(t_b - t)$$

where i_t is the partial outlay made at the time t after construction was started, t_b is the total construction period, and $i_t(t_b - t)$ is the 'freeze' of the partial outlay i_t. Let us replace the above by In_z, where I is the total investment outlay and, therefore, is equal to

$$\sum_0^{t_b} i_t$$

whereas n_z is the 'freezing period' equal to the volume of the 'freeze' divided by total investment outlay. If investment outlays are evenly distributed over construction time, $n_z = t_b/2$; if they are concentrated at the beginning of construction, $n_z > t_b/2$; if they are concentrated at the end of construction, $n_z < t_b/2$.

Let us now consider the impact of the 'freeze' of investment resources in the course of construction[2] on the economy. In our simplified model in which construction of plant is 'instantaneous', resources 'frozen' gradually in the course of construction would be at the disposal of the national economy for an immediate generation of output. Let q_z be the net national product generated per unit of investment resources p.a. (the value of q_z will presently be discussed in greater detail). The yield of the partial outlay till the completion of the plant would be $i_t q_z(t_b - t)$. It follows that in our simplified model the total additional yield would be $Iq_z n_z$.

[2] The argument that follows is based on the same approach as the paper of M. Kalecki, 'O współczynniku zamrożenia' (On the Coefficient of Freezing) in *Ekonomista*, 1 (1959) [see *Collected Works*, vol. iii].

In other words, as a result of the 'freeze' the outlay on the plant is—in relation to the simplified model—$I(1 + q_z n_z)$ rather than I. Thus, (1) assumes the form

$$E = \frac{I \cdot \frac{1}{T} \cdot (1 + q_z n_z) + K}{P} \tag{2}$$

There remains the problem of determination of q_z, i.e. of the net national product yielded annually by a unit of investment outlay which in fact is 'frozen' in the course of construction, but in our simplified model with 'instantaneous construction' is 'harnessed to production'. Let us assume that these outlays yield a national product of an average sectoral pattern and let m stand for the capital–output ratio (this means that in order to obtain one złoty of the annual gross national product an investment of m złotys is required). Thus gross product yielded by one złoty spent on investment is $1/m$ p.a. and, allowing for depreciation of fixed capital at a rate v, net national product is $1/m - v$ p.a. It would seem prima facie that q_z equals the difference $1/m - v$, but an essential corrective must be still introduced into our argument.

The point is that an increment of national product requires additional employment as well as investment. When the balance of the labour force is in equilibrium some investment outlay must be incurred in order to release elsewhere in the economy the required workers.

Thus, in order to obtain an increment d of the gross national product some investment as a substitute for the labour force necessary in the production of d is required in addition to the direct investment md. Let rd stand for wage cost corresponding to the increment d; assuming an upper limit of the recoupment period T the corresponding investment is Trd. Thus the increment d of the gross national product requires a total investment outlay of $md + Trd$, while the gross national product yielded by one złoty of investment outlay is

$$\frac{d}{md + Trd} = \frac{1}{m + Tr}$$

In other words, when the balance of the labour force is in equilibrium the annual net product of one 'unfrozen' investment złoty is $[1/(M + Tr)] - v$ rather than $1/m = v$.

We thus arrive finally at the following formula

$$q_z = \frac{1}{m + Tr} - v$$

Assuming for Poland $m = 2.5$, $T = 6$, $r = 0.5$, and $v = 0.03$ we obtain

$$q_z = \frac{1}{2.5 + 6.0.5} - 0.03 = 15\%$$

3. Modification of the Formula for Non-Standard Durability of Plant

We have assumed so far that all the plant has the same standard durability n_s. Thus the formulae arrived at cannot be applied when projects of plant of different durabilities are compared. We shall now try to determine the correctives for output and costs which enable us to substitute a project of lifetime n_s for one with durability n.

Les us consider aggregate investment in the plant of a durability of n years. Let us suppose that investment of this type per unit of time grows at a rate a p.a. and that the capital–output ratio is m.

We assume moreover that m does not change over time. Thus if investment of the type considered maturing in a given year is J, then in the preceding year it was $J/1 + a$ and $(i - 1)$ years back it was $J(1/1 + a)^{i-1}$. Thus the stock of fixed capital operating in a given year is the sum of investment carried in past n years or

$$M_n = \sum_{i=1}^{n} J\left(\frac{1}{1+a}\right)^{i-1} = J\,\frac{\left[1 - \left(\frac{1}{1+a}\right)^{n}\right](1+a)}{a}$$

Since the capital–output ratio is m the output out of this stock of fixed capital is

$$F_n = \frac{M_n}{m} = J\,\frac{\left[1 - \left(\frac{1}{1+a}\right)^{n}\right](1+a)}{am}$$

Let us now determine the output for an identical flow of investment in the plant characterized by the same capital–output ratio m but having a standard durability n_s. We obtain

$$F_{n_s} = \frac{M_{n_s}}{m} = J\,\frac{\left[1 - \left(\frac{1}{1+a}\right)^{n_s}\right](1+a)}{am}$$

Thus the same flow of investment results in a larger output if the durability of the plant is higher and the advantage from construction of the plant of a durability greater than n is shown by the ratio

$$\frac{F_n}{F_{n_s}} = \frac{1 - \left(\frac{1}{1+a}\right)^{n}}{1 - \left(\frac{1}{1+a}\right)^{n_s}} = Z_n > 1$$

The advantage would be highest in the case of a approaching 0, i.e. in the case of nearly a simple reproduction.[2] Then $Z_n = n/n_s$, which means that with a greater durability of the plant and a given flow of investment the output grows in proportion to the durability n. However, under conditions of expanded reproduction, i.e. when the rate of investment increases continuously, advantages from a higher durability are considerably reduced since (the smaller) investment volumes of earlier years exert a correspondingly smaller influence on total output.

Indeed if we assume a equal to 7% corresponding to the actual annual rate of growth of productive investment in Poland, we obtain for n_s = twenty years the following values of the coefficient Z_n:

n (years)	5	10	15	20	25	30	35	40	∞
Z_a (%)	38.6	66.1	86.0	100.0	110.0	117.0	123.0	126.0	131.0

It will be seen that for a life-span twice the standard one, the increase in output is only 26% and for an inifinite durability—only 31%. This shows clearly that in an expanding economy a greater durability of plant gives a smaller advantage than in an economy subject to simple reproduction.

Now let us imagine that we replace every plant of a durability of n years and capital–output ratio m by a plant of a standard durability n_s and of a capital–output ratio m/Z_n. Thus, if the capacity of the actual plant is P, the capacity of the imaginary substitute plant is PZ_n. It will be easily seen that in either case, actual or imaginary, to the same flow of investment there corresponds the same flow of output. Indeed, the capacity of the actual plant is P and that of the fictitious plant PZ_n. On the other hand, the same flow of investment yields in the case where the durability of the plant is n a flow of output Z_n times larger than in the case where the durability is n_s.

Obviously to a longer plant lifetime there corresponds a larger flow of costs as well as a larger flow of output. To account for this factor we can follow an analogous line of argument as in the case of output, although an essential modification must be introduced. Indeed, if the investment flow increases at a rate a p.a. the aggregate production costs in the plant completed in a given year increase at a rate c p.a., c being smaller than a owing to technical progress, which reduces continuously production costs per unit of output. The same argument as in the case of output leads to the conclusion that to the same flow of investment there corresponds in the case of a durability higher than n_s aggregate production costs Y_n times higher, Y_n being determined by the formula

$$Y_n = \frac{G_n}{G_{n_s}} = \frac{1 - \left(\frac{1}{1+c}\right)^{n}}{1 - \left(\frac{1}{1+c}\right)^{n_s}}$$

where G_n and G_{n_s} are the total of production costs for durabilities n and n_s respectively.

For $n_s = 20$ and $c = 3\%$ the values of Y_n are as follows:

n (years)	5	10	15	20	25	30	35	40	∞
Y_a (%)	31	57	80	100	117	132	145	155	227

Following again the same line of argument as in the case of output, we can demonstrate that production costs in the imaginary substitute plant of standard durability n_s should be Y_n times higher. Thus if the costs in the actual plant of durability n are K, then the costs of the imaginary substitute plant of durability n_s are KY_n.

Therefore, if the durability of the plant considered is n years, its output is P, and its current production costs are K, then this project can be replaced by an equivalent of a durability n_s whose investment outlay would be the same, i.e. I, but whose output would be PZ_n and costs KY_n. Thus, the formula for efficiency of investment for the project of the plant of durability n assumes the form

$$E = \frac{I \cdot \frac{1}{T}(1 + q_z n_z) + KY_n}{PZ_n} \tag{3}$$

This equation may also be written as

$$E = \frac{I \frac{1}{T}(1 + q_z n_z)\frac{1}{Z_n} + K\frac{Y_n}{Z_n}}{P}$$

The higher efficiency of investment in the case where durability of the plant exceeds the standard period is expressed in this equation by $I(1 + q_z n_z)$ being divided by Z_n. On the other hand, multiplication of current costs K by Y_n/Z_n (the value of this fraction is > 1) reduces the efficiency of investment. The latter reflects the loss caused by fixing the level of current costs for a longer period in the more durable plant, which circumscribes opportunities for taking advantage of technical progress. Which of these two influences prevails depends on relative values of K and $I(1 + q_z n_z)$. With a given proportion of K and $I(1 + q_z n_z)$ there will be a certain value of n at which E will reach its minimum, i.e. the efficiency of investment will be at its highest level. Below this optimum n efficiency is lower because the gain in output through a longer period of the operation of the plant is greater than the loss through incurring the relatively high costs by using outmoded equipment. When n is above the optimum the position is reversed. It is clear that in calculation of the efficiency of investment n must be adopted at a level which minimizes E. Thus the formula (3) determines in fact the durability n of the plant as well. This is as it should be, the durability being an economic rather than a technological parameter.

It should be noted that the rate of growth of output in the newly completed establishments a and the respective rate of growth of costs c may differ for various classes of plant durability, i.e. for different values of n. In the absence of data on the subject as well as for the sake of simplicity we assumed uniform a and c namely 7% and 3% for all durability classes.

4. Modification of the Formula to Account for the Variability of Output and Costs during the Lifetime of the Plant

Let us consider again a flow of output yielded by plant of a durability of n years, where respective investment per unit of time grows at a rate a p.a. The formula obtained above for the stock of fixed capital in a given year is

$$M_n = \sum_{i=1}^{n} J\left(\frac{1}{1+a}\right)^{i-1}$$

where J stands for the rate of investment in that year.

We abandon now the assumption that output is constant throughout the lifetime of the plant. Let us divide the plants into classes according to the shape of time-curves of output during their existence. We assume, moreover, that all the partial flows of investment corresponding to these classes show the same rate of growth. Thus, the above formula for the stock of fixed capital in a given year remains valid for each partial flow of investment. (Now J will be the investment in that year and M the stock of fixed capital in that year related to the partial investment flow.)

Let us now find the output generated by the partial investment flow in a given year. Let w_i stand for the ratio of the output of plant in the year i of its life to the value of its fixed capital. In a given year the output of the plant, completed $i - 1$ years back is characteristic for the year i of its existence. Thus the output of the plant completed $i - 1$ years back is determined by the expression

$$J\left(\frac{1}{1+a}\right)^{i-1} . w_i$$

Consequently, the formula for the output generated by a partial flow of investment we are considering (characterized by a given distribution curve of output over the time of existence of the plant) is

$$F_n = \sum_{i=1}^{n} J\left(\frac{1}{1+a}\right)^{i-1} . w_i$$

Now let us suppose that the same amount of the output F_n is obtained from the same flow of investment with a constant w. We then obtain:

$$\sum_{i=1}^{n} J\left(\frac{1}{1+a}\right)^{i-1} . w_i = \sum_{i=1}^{n} J\left(\frac{1}{1+a}\right)^{i-1} . w_{\text{const}}$$

where w_{const} may be called the equivalent of the sequence w_i. It follows from this formula that

$$w_{\text{const}} = \sum_{i=1}^{n} J\left(\frac{1}{1+a}\right)^{i-1} . w_i : J\frac{\left[1-\left(\frac{1}{1+a}\right)^{n}\right](1+a)}{a}$$

Now only one more step is necessary in order to reduce the case in which output varies in the course of the life-span of the plant to one with constant output. Let us replace every plant having a specified uneven output distribution by another plant involving the same investment outlay but with a constant output of the volume

$$P_{\text{const}} = \sum_{i=1}^{n} P_i\left(\frac{1}{1+a}\right)^{n-i} : \frac{1-\left(\frac{1}{1+a}\right)^{n}(1+a)}{a}$$

We now see that the imaginary substitute plant yields the same flow of output as the actual plant. In this way the last formula determines the volume of constant output as an equivalent of variable output. This formula is based on the assumption that the partial flows of investment corresponding to the different types of output distribution over time maintain a constant relative share in the total flow of investment, and thus it is merely an approximation to reality. (The assumption involved is analogous to adopting the same a for various durability classes of plants in the preceding section.)

A similar argument can be applied to costs varying in the course of the existence of the plant. We shall obtain for the equivalent of variable costs the following formula

$$K_{\text{const}} = \sum_{i=1}^{n} K_i\left(\frac{1}{1+c}\right)^{i-1} : \frac{\left[1-\left(\frac{1}{1+c}\right)^{n}(1+c)\right]}{c}$$

We may now generalize the formula for the efficiency of investment in order to account for the variation of output and costs during the life-span of the plant by substituting P_{const} and K_{const} as determined by the above formulae for P and K. We then obtain

$$E = \frac{J\frac{1}{T}(1+q_z n_z) + K_{\text{const}}\,Y_n}{P_{\text{const}}\,Z_n} \tag{4}$$

This formula for the efficiency of investment accounts for the 'freeze' of capital in the course of construction, for the durability of the plant being different from the standard one, and for the variability of output and costs over time.

It should be emphasized that we regard the formulae arrived at here as no more than a better approximation to the complex economic reality than those now in use rather than as a final solution of the problem.

A Rejoinder to Mr A. Święcicki [1]

(1961)

The 'Analysis of the Generalized Formula for Efficiency of Investment' is unfortunately founded on a misunderstanding of the formula, of the way it was derived, and of its application. In this paper I will attempt to clarify one by one the misunderstandings it helped to create.

1. Y_n and Z_n are not determined by the 'discounting of outlay and the value of output over the whole period of operation, estimated at the moment the plant is commissioned for operation'. Moreover, c does not represent 'the value of average reduction in the unit cost of production in the national economy', but it stands for the average growth in the total cost incurred in new plants.

It seems necessary first to explain the meaning of the coefficients Y_n and Z_n in the generalized formula for efficiency of investment. Let us suppose that plants whose durability differs are compared with each other. How is their efficiency calculated? We may use the following argument. Let us imagine an increasing flow of plants of a given type. Let us denote by J investment of this type per unit of time, undertaken at any given moment, and by a the annual rate of growth of this type of investment. On the diagram, where time t is plotted as the abscissa and investment I as the ordinate, the trajectory of this investment up to the moment A' is represented by the curve NA (see Fig. 30). Let the durability of a given plant be n years. The volume of this capital then corresponds to the shaded area $NN'A'A$ since the investment undertaken prior to time N' has already gone out of operation, and plants built at a later date than A' are not yet operational.

The shaded area is equal to $[1-(1+a)^{-n}]/a$. Hence, *ceteris paribus*, the output from the plants in question is proportionate to the value of this fraction, which is an increasing function of n. It can then be said that this expression reflects a rise in the productivity of investment which corresponds to extending their durability of operation, n. Hence the productivity of investment of a plant with a durability equal to n and a volume of output equal to P_{st} is equivalent to that of a plant which has a certain

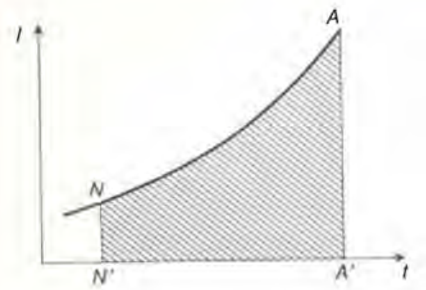

FIG. 30

standard durability n_s, and a volume of output equal to $\{P_{st}[1-(1+a)^{-n}]\}/[1-(1+a)^{-n_s}]$. Let us denote the expression $[1-(1+a)^{-n}]/[1-(1+a)^{-n_s}]$ by Z_n. Thus, in order to bring the durability n to the standard durability n_s, we multiply P_{st} by Z_n in the denominator of our formula.[1]

A similar argument can be applied to cost. The total cost of all plants operating at a given time is equal to total cost of all plants built over n years which preceded this moment. The total cost of plants constructed in any given year grows slower than investment I due to a decrease in the unit cost. The growth rate of unit cost is therefore $c < a$. In effect, when estimating the costs, one should not apply the coefficient Z_n, but the coefficient $Y_n = [1-(1+c)^{-n}]/[1-(1+c)^{-n_s}]$.[2] In empirical applications of the generalized formula, it was assumed that $n_s = 20$; $a = 7\%$; $c = 3\%$.

2. Here is how our formula was derived. It is clear that the above argument has nothing to do with 'discounting of outlays and the volume of output over the whole period of operation estimated for the moment the plant is commissioned for operation'. Such discounting applies to cost and output value in successive years of operation of a *given plant*, whereas our argument refers to a flow of plants of a given type which were built prior to the

[1] See M. Kalecki and M. Rakowski, 'Generalized Formula of the Efficiency of Investment' [p. 125–6, this volume].
[2] Ibid. [p. 126].

moment under consideration. Following a rather peculiar interpretation of our formula, Mr Święcicki describes the sad fate of the enterprise which would supposedly be the consequence of our logic.

If, as the authors assume, the production cost K_{st} drops annually by 3%, and the value of output P_{st} by 7%, then given the initial ratio of K_{st}/P_{st} equal to, say, 0.8, the fall in the plant's profits already after the first year of operation will be 3.4% of the value of production, and it will continue to fall year by year. Despite a good start (20% profit margin in the first year of operation), by the sixth year of its operation the plant will start to incur losses. After 20 years, which is the standard durability postulated by the authors, the plant in question would operate under a huge deficit.[3]

We did not assume that the plant's output would annually decrease by 7% and that its current costs would drop by 3%. We assumed instead that productive investment increases annually by 7%, and that the total cost in new plants grows by 3%. Reading this passage of Święcicki's article indeed leads to sad conclusions, but not because of the fate of the plant which he describes.

3. Our formula for the efficiency of investment can be represented as $E = (1/T)[I(1 + q_z n_z)]/Z_n P_{st} + Y_n K_{st}/P_{st}$. Z_n is an increasing function of n. The same applies to Y_n/Z_n. Therefore, as Święcicki rightly points out, the first element decreases, while the second one increases with n. Given the ratio of I to K_{st} which one encounters in practice, when n grows, E decreases up to a point but later begins to grow. There exists, therefore, an optimum durability period at which E reaches its minimum. At first sight this may seem strange. Why should longer plant durability be less advantageous? However, let us remember that the longer the durability period, the higher is the number of technologically obsolete plants, where costs of production are relatively high. This is reflected in the increase in the $(Y_n/Z_n)(K_{st}/P_{st})$ factor together with the lengthening of plant durability. In turn, a decrease in the $(1/T)\{[I(1 + q_z n_z)]/(Z_n P_{st})\}$ factor reflects the advantages of longer durability of the invested capital. The value of n_{opt}, which follows from our formula, takes into account the so-called moral depreciation of capital.

[3] A. Święcicki, 'On the Generalized Formula of the Efficiency of Investment', *Ekonomista*, 54/5 (1961), pp. 1169–70 [in Polish].

It is easy to note that n_{opt} is a function of I/K_{st} ratio. The higher is this fraction, the higher is the n_{opt}. Mr Święcicki attempts to determine the value of I/K_{st} corresponding to n_{opt} equal to the standard durability period of twenty years. He solves this problem in a rather 'original' manner, i.e. by assuming that E reaches its minimum when its two elements which change in opposite directions are equal to each other. It should be no secret to him, however, that what is equal at n_{opt} is a fall in the first factor and *an increment* in the second, when n increases a little. This condition for I/K_{st} gives the value of 3.3, not 4.62 which he calculated.

Mr Święcicki next observes that in a number of cases the ratio of I/K_{st} would be lower than the one which corresponds to $n_{opt} = 20$, and he considers this to be an argument against our formula. In reality, it merely means that in these cases n_{opt} is less than twenty years; this conclusion seems in no way to undermine our formula.

It must be noted as well that K_{st} should be calculated, as observed by the above author, net of the value of raw materials. The fact that the cost coefficient is Y_n, and the production coefficient is Z_n, follows from lower unit cost of production in new plants. It is the consequence of increased productivity of labour, whereas progress in the intake of raw materials is usually small. Hence, in the first approximation, in most cases one would use the formula

$$E = \{(1/T)[I(1 + q_z n_z)] + Y_n K'_{st} + Z_n K''_{st}\}/Z_n P_{st}$$

or

$$E = (1/T)I(1 + q_z n_z)/Z_n P_{st} + (Y_n/Z_n)(K'_{st}/P_{st}) + K''_{st}$$

where K'_{st} is the cost of labour and K''_{st} is the cost of raw materials.[4] It is clear that for determining n_{opt} the ratio of I/K'_{st} is decisive.

4. It follows from the above that in applications of our formula the durability period should always be set at n_{opt}. The paradoxes which were encountered in the past stemmed from failing to apply this rule in a precise manner. Here is an example. In one variant of the investment project, investment outlays were I, costs were

[4] In such industries as power-generating, where one may expect significant progress in the use of fuels, this formula would have to be slightly modified.

K, and n was assumed to be equal to n_{opt}, corresponding to I/K_{st}. In the second variant investment and cost were 10% lower, i.e. they were $0.9I$ and $0.9K$ respectively, and much higher n was assumed. The second variant, despite lower investment outlays and current cost, appeared then to have a worse efficiency coefficient than the first one. The explanation of this paradox is very simple. Since the ratio of investment to current costs was the same in the two variants, n_{opt} was also the same, and the durability period in the second variant should be set not at a higher but at the same level, too. Then in the second variant the coefficient E would be 10% lower than in the first one.

5. I think that explaining our formula in terms of the rate of interest is not very helpful. Mr Święcicki gives a good example of this by arguing that the recoupment period T equal to six years implies a rate of interest equal to $1/T = 17\%$. If one wants to interpret $1/T$ in these terms, then it should be taken into account that the inverse of the recoupment period is composed of depreciation and interest (K_{st} *does not* include depreciation).

The author's ideas on freezing of capital are not clear. However, I think I have understood their essence. If the 'freezing period' of investment resources is shortened by one year, they will bring yield one year earlier. This will allow making economies on operating costs equivalent to $(1/T)I$. These economies will in turn be used for investment, which will give us permanent economies on costs corresponding to $(1/T^2)I$. The coefficient of 'freeze', q_z, should therefore be set at such a level that the benefits from shortening the 'freezing period' by one year, or of reducing the numerator of our formula by $(1/T)q_z I$ should be equal to these economies, $(1/T^2)I = (1/T)q_z I$. Hence it follows that $q_z = 1/T$.

There are two flaws in this argument. First of all, economies in operating cost, gained by the national economy due to investment outlay, should be weighted against the cost of depreciation. Secondly, the fact that inputs of labour are reduced does not mean that one can produce capital goods to the value of the wages saved, because to increase output of investment goods one needs also capital equipment. It is for this reason that in our formula the impact of the 'freeze' of investment resources is accounted for in a different way: the advantages of 'unfreezing' the capital and making it available for the national economy in order to increase output are set against the value of depreciation of capital and the mechanization outlay which must be incurred in order to release the required labour supply.[5]

The contradictions which Mr Święcicki discovers in our formula are simply the result of the fact that we do not postulate q_z to be equal to $1/T$ (incidentally, in the course of his argument he makes some mistakes, such as in the formula presented in the footnote, where the fraction should be 7/6, not 6/5).

6. Finally, turning to the question of interest on working capital Mr Święcicki writes:

> Unfortunately also in this respect the formula in question leads to doubtful conclusions. As far as durable assets I are concerned, their ratio to the annual output P_{st} is corrected by a coefficient $1/TZ_{n'}$, and the ratio of working capital O_s to the annual output is corrected by a coefficient $q_z = 0.15$. These coefficients will be equal to each other when $z_n = 1.1111$, which corresponds to the durability period of some 25 years. It is only if plant durability is longer than this, that the formula will speak in favour of a variant which for the same volume of output and the same value of all inputs makes fuller use of the working capital. In the formula it will find expression in this that only then will durable assets bear higher interest than working capital (proof: $1/6Z_n \times 0.15$; $Z_n \times 1.1111$).[6]

This is not quite so. $1/TZ_n$ will be higher than 0.15 for n shorter than twenty-five years since Z_n increases together with n. Only for periods longer that $n = 25$ will $1/TZ_n$ be less than 0.15. Furthermore, as already mentioned, $1/T$ is not interest, since operating cost does not here include depreciation. The same applies to $1/TZ_n$. This, in fact, supports Święcicki's argument; only its premise—the 'liquidity preference'—appears to me to be wholly unjustified.

7. At the end Mr Święcicki writes: 'Thus we arrive at the conclusion that the discussed formula of efficiency of investment does not solve the objectives set by its authors and occasionally even solves them in a manner which is contrary to their intentions.'[7]

Perhaps prior to passing such judgement it is worth while to try to understand what one sets out to criticize.

[5] [See pp. 123–5, this volume.]
[6] 'On the Generalized Formula of the Efficiency of Investment', p. 1171.
[7] Ibid.

Efficiency of an Investment Programme[1]
(1962)

1. The study of the efficiency of investment is usually meant to apply to a single plant. However, already the decision on stages for completion of such an investment project falls outside the scope of such a study and calls for examining the efficiency of an investment programme. By a programme we mean here simply a plan to construct a set of plants which turn out a given product and which are planned to be completed at various moments over a given period of time. The simplest programme would consist of planned completion of two plants, at t_1 and t_2. Let us start with this case, which can later easily be generalized to cover a series of plants completed at different times. Let us for the time being assume also that both plants have the same durability which is equal to standard durability period, e.g. twenty years.[1] Of course, this assumption will be discarded later on.

2. Investment outlay and the annual current costs of the plant entering production at t_1 will be denoted by I_1 and K_1, and of the plant put into operation at t_2 by I_2 and K_2, the latter being calculated at prices and wage rates of t_1 period. The annual outputs of the two plants are equal to P_1 and P_2 respectively. Let us imagine that these two plants constitute a 'set', i.e. if at time t one plant is completed, which is characterized by I_1, K_1 and P_1, then $t_2 - t_1$ later, or at the time $t + t_2 - t_1$ the plant characterized by I_2, K_2, and P_2 will be put into operation. The first and the second plant will be regarded here as respective parts of investment flows i' and i'', which means that investment of the first type per unit of time is i' and that of the second type is i''. It is easy to see that there are some interdependencies between i' and i''.

In the year t, a certain number of plants of the first type is put into operation; the total investment outlay for this purpose is by definition equal to i_t'. The same number of plants of the second

[1] See M. Kalecki and M. Rakowski, 'Generalized Formula of the Efficiency of Investment' [this volume].

type is put into operation in time $t_2 - t_1$. Total investment outlay in these plants is equal to i_t''. It follows that the ratio of $i''_{t+t_2-t_1}$ to i_t' would be the same as the ratio of outlay per plant of the second type to that of the first type. We then have

$$i''_{t+t_2-t_1}/i_t = I_2/I_1 \tag{1}$$

Of course both i_t'' and i_t' increase with time. Let us assume that the growth rate of i_t'' is equal to a% (say 7%) per annum (as we shall see, from equation (1) it also follows that i_t' will have to grow at the rate of a too). We then have

$$i''_{t+t_2-t_1} = i_t''(1+a)^{t_2-t_1} \tag{2}$$

Substituting this value of $i''_{t+t_2-t_1}$ into equation (1) we have

$$i_t''(1+a)^{t_2-t_1}/i_t' = I_2/I_1$$

or

$$i_t'' = (i_t'/I_1)/(I_2/(1+a)^{t_2-t_1} \tag{3}$$

From this equation it follows that if, as planned, i_t'' grows at the rate of a, then i_t' grows at the same rate, since I_1, I_2, a, and $t_2 - t_1$ are all constant.

From equation (3) we can derive the formula for total flow of plants of the first and the second type by adding i_t' to both sides of equation (3)

$$i_t' + i_t'' = (i_t'/I_1)\,[I_1 + I_2/(1+a)^{t_2-t_1}] \tag{4}$$

3. The flows of investment outlay i_t' and i_t'' generate flows of output π_t' and π_t''. We assumed that for both types of plant under consideration the durability period is equal to n_s, i.e. it is equal to the standard durability (e.g. twenty years). In both cases capital stock will therefore consist of investment completed over past n_s years, since older plants have already gone out of operation. Since investment i_t' and i_t'' grow at the rate of a (i.e. at 7% per annum), the volume of capital stock at time t will be

$$A_t' = i_t'[1 + 1/(1+a) + 1/(1+a)^2 + \ldots + 1/(1+a)^{n-1}] \tag{5}$$

and

$$A_t'' = i_t''[1 + 1/(1+a) + 1/(1+a)^2 + \ldots + 1/(1+a)^{n-1}] \tag{6}$$

respectively.

It follows from these equations that A'_t and A''_t grow at the same rate a as i'_t and i''_t, since the expression in the square brackets is constant. Dividing equation (6) by equation (5) we obtain

$$A''_t / A'_t = i''_t / i'_t \tag{7}$$

Output at time t is equal to the volume of the productive capital multiplied by the capital–output ratio, which for the two types of plants under consideration is respectively P_1/I_1 and P_2/I_2. We then have

$$\pi'_t = A'_t / (P_1/I_1) \tag{8}$$

and

$$\pi''_t = A''_t / (P_2/I_2) \tag{9}$$

Since the volumes of the capital stock A'_t and A''_t grow at the rate a, it follows from equations (8) and (9) that the outputs π'_t and π''_t also grow at the same rate. Dividing equation (9) by equation (8) we get

$$\pi''_t / \pi'_t = (A''_t / A'_t)(P_1/P_2)(I_2/I_1) \tag{10}$$

and taking under consideration equation (7)

$$\pi''_t / \pi'_t = (i''_t / i'_t)(P_1/P_2)(I_2/I_1) \tag{11}$$

Finally from this equation and from equation (3) we derive

$$\pi''_t = (\pi'_t / P_1)[P_2/(1+a)^{t_2 - t_1}] \tag{12}$$

By adding π'_t to both sides of this equation, we now obtain, for production generated jointly by the two flows of investment, an equation which is similar to equation (4)

$$\pi'_t + \pi''_t = (\pi'_t / P_1)[P_1 + (P_2)/(1+a)^{t_2 - t_1}] \tag{13}$$

4. The same argument may be applied to current production costs. However, we should take into account that with investment growing at the rate a, current costs in plants newly put into operation in any given year increase at a lower rate c, because technical progress reduces unit costs of production. In consequence equation (12) will be rewritten as follows

$$\kappa''_t = (\kappa'_t / K_1)[K_2/(1+c)^{t_2 - t_1}] \tag{14}$$

where κ'_t and κ''_t stand for flows of cost corresponding to the flows of output π'_t and π''_t. It can be easily demonstrated that

κ''_t and κ'_t grow at the rate c. Adding κ'_t to both sides of equation (14) we come up with an equation of cost corresponding to the joint flow of output $\kappa'_t + \kappa''_t$

$$\kappa'_t + \kappa''_t = (\kappa'_t / K_1)[K_1 + K_2/(1+c)^{t_2 - t_1}] \tag{15}$$

5. Let us now put together equations (4), (13), and (15) which represent the joint flows of investment outlay, output, and costs in both plants under consideration

$$i'_t + i''_t = (I'_t / I_1)[I_1 + I_2/(1+a)^{t_2 - t_1}] \tag{4}$$

$$\pi'_t + \pi''_t = (\pi'_t / P_1)[P_1 + P_2/(1+a)^{t_2 - t_1}] \tag{13}$$

$$\kappa'_t + \kappa''_t = (\kappa'_t / K_1)[K_1 + K_2/(1+c)^{t_2 - t_1}] \tag{15}$$

Let us now imagine that in the first flow we replace the plants with attributes I_1, K_1, and P_1 with those which have the attributes $[I_1 + I_2/(1+a)^{t_2 - t_1}]$, $[K_1 + K_2/(1+c)^{t_2 - t_1}]$, and $[P_1 + (P_2)/(1+a)^{t_2 - t_1}]$. From the above equations it follows that the flows of investment outlay, output, and costs in plants with these new attributes will coincide with the respective total flows of investment outlay, output, and costs in plants of the first and second type taken together. Indeed, at time t investment per unit of time in this flow will be equal to $i'_t + i''_t$, output to π'_t and π''_t, and costs to κ'_t and κ''_t. Therefore from the point of view of the efficiency of investment, a plant with attributes $[I_1 + I_2/(1+a)^{t_2 - t_1}]$, $[K_1 + K_2/(1+c)^{t_2 - t_1}]$, and $[P_1 + (P_2)/(1+a)^{t_2 - t_1}]$ may be considered equivalent to a set of plants with attributes I_1, K_1, P_1, and I_2, K_2, P_2, of which the second type of plant is put into operation at time $t_2 - t_1$ later than the first type. The efficiency of this set of plants can be calculated as the efficiency of the substitute plant

$$E_{\text{progr}} = \frac{\dfrac{1}{T}\left[I_1 + \dfrac{I_2}{(1+a)^{t_2 - t_1}}\right] + K_1 + \dfrac{K_2}{(1+c)^{t_2 - t_1}}}{P_1 + \dfrac{P_2}{(1+a)^{t_2 - t_1}}} \tag{16}$$

where E_{progr} is the coefficient of efficiency of the investment programme, which in this case consists of the putting into operation of two plants at times t_1 and t_2 respectively, and where T is the recoupment period. (For the sake of simplicity, in this and the following equations the problem of the 'Frozen' investment outlay has been neglected.) Let us now transform equation (16) as follows

$$E_{\text{progr}} = \frac{\frac{1}{T}I_1 + K_1 + \frac{1}{(1+a)^{t_2-t_1}}\left[\frac{1}{T}I_1 + K_2\left(\frac{1+a}{1+c}\right)^{t_2-t_1}\right]}{P_1 + \frac{P_2}{(1+a)^{t_2-t_1}}}$$

What is the meaning of the expression $K_2[(1+a)/(1+c)]^{t_2-t_1}$? The component $(1+a)/(1+c)$ represents the annual fall in unit cost due to technical progress (production grows at the ratio $1+a$, while cost at the ratio $1+c$). Hence $K_2[(1+a)/(1+c)]^{t_2-t_1}$ is the cost of plant put into operation at t_2 but calculated at unit costs at t_1. We can, therefore, denote $K_2[(1+a)/(1+c)]^{t_2-t_1}$ as $K_{2,1}$; these subscripts indicate that K_2 cost is expressed in terms of prices and wage rates existing at the time t_1. Introducing this into the above formula, and dividing and multiplying the components of the numerator by P_1 and P_2 respectively, we get

$$E_{\text{progr}} = \frac{P_1\frac{\frac{1}{T}I_1 + K_1}{P_1} + \frac{P_2}{(1+a)^{t_2-t_1}}\frac{\frac{1}{T}I_2 + K_{2,1}}{P_2}}{P_1 + \frac{P_2}{(1+a)^{t_2-t_1}}} \tag{17}$$

With the standard durability period, we then have the following formulae for the efficiency of investment[2]

$$E_1 = [(1/T)I_1 + K_1]/P_1$$

and

$$E_2 = [(1/T)I_2 + K_{2,1}]/P_2$$

If E_2 is to represent the coefficient of efficiency of the second plant, calculated at unit cost of time t_1, then formula (17) can be written as follows

$$E_{\text{progr}} = \frac{P_1E_1 + \frac{P_2}{(1+a)^{t_2-t_1}}E_2}{P_1 + \frac{P_2}{(1+a)^{t_2-t_1}}} \tag{18}$$

[2] See 'Generalized Formula of the Efficiency of Investment' [this volume].

6. So far we have assumed that durability of both types of plants was equal to the standard durability period n_s. We will now discard this assumption; let the durability of the first plant be n_1 and of the second plant n_2 years. In the article to which we referred above it was shown that from the point of view of investment, cost, and output, the flow of plants with I, K, and P attributes, as well as with the n-year durability period, is equivalent to a plant with I, KY_n, PZ_n, and n_s attributes, where Y_n and Z_n are coefficients dependent on the durability period n. Furthermore, Z_n depends on the rate a at which investment and output are growing, while Y_n depends on the rate of growth of costs, c. We can now imagine that flows of output, investment, and current costs in plants of both types are replaced with flows bearing the attributes of I, KY_n, PZ_n, and n_s, and I_2, $K_2Y_{n_2}$, $P_2Z_{n_2}$, and n_s respectively. It follows directly that equation (17) can now be represented as follows

$$E_{\text{progr}} = \frac{P_1Z_{n_1}\frac{\frac{1}{T}I_1 + K_1Y_{n_1}}{P_1Z_{n_1}} + \frac{P_2Z_{n_2}}{(1+a)^{t_2-t_1}}\frac{\frac{1}{T}I_2 + K_{2,1}}{P_2Z_{n_2}}}{P_1Z_{n_1} + \frac{P_2Z_{n_2}}{(1+a)^{t_2-t_1}}} \tag{19}$$

Then we have

$$E_1 = [(1/T)I_1 + K_1Y_{n_1}]/P_1Z_{n_1}$$

and

$$E_2 = [(1/T)I_2 + K_{2,1}Y_{n_2}]/P_2Z_{n_2}$$

where E_2 stands for the coefficient of efficiency of the second plant calculated at unit cost of t_1.

Equation (19) can now be written as follows[3]

[3] The argument was based so far on the assumption that the current cost grows from year to year at a rate c which is lower than the rate of growth of investment and output a. However, the situation may, and often will be different: while the cost of labour will grow slower than output, the intake of raw materials will grow at the same rate. Yet, it appears that even in this case equation (20) remains valid. Let us denote current cost as the sum $K+S$, where K is the cost of labour and S is the cost of raw materials. We assume that if investment and output grow at the rate a, then so does S while K grows at the rate c. Under

$$E_{\text{progr}} = \frac{P_1 Z_{n_1} E_1 + \dfrac{P_2 Z_{n_2}}{(1+a)^{t_2 - t_1}} E_2}{P_1 Z_{n_1} + \dfrac{P_2 Z_{n_2}}{(1+a)^{t_2 - t_1}}} \tag{20}$$

or, if we assume for the sake of simplicity that $t_1 = 0$, as

$$E_{\text{progr}} = \frac{P_1 Z_{n_1} E_1 + \dfrac{P_2 Z_{n_2}}{(1+a)^{t_2 - t_1}} E_2}{P_1 Z_{n_1} + \dfrac{P_2 Z_{n_2}}{(1+a)^{t_2}}} \tag{20'}$$

7. It can easily be seen that the above argument can be applied not for two, but for k number of plants put into operation at time $t_1 = 0$, t_2, t_3, . . . t_k. We then have the following formula

$$E_{\text{progr}} = \frac{P_1 Z_{n_1} E_1 + \dfrac{P_2 Z_{n_2}}{(1+a)^{t_2}} E_2 + \dfrac{P_3 Z_{n_3}}{(1+a)^{t_3}} E_3 + \ldots + \dfrac{P_k Z_{n_k}}{(1+a)^{t_k}} E_k}{P_1 Z_{n_1} + \dfrac{P_2 Z_{n_2}}{(1+a)^{t_2}} + \dfrac{P_3 Z_{n_3}}{(1+a)^{t_3}} + \ldots + \dfrac{P_k Z_{n_k}}{(1+a)^{t_k}}} \tag{21}$$

where the coefficients of efficiency $E_1, E_2, E_3, \ldots, E_k$ are calculated at unit costs of the initial period. The above formula shows that the coefficient of the efficiency of an investment programme is a weighted average of the efficiency of individual plants calculated in terms of production cost of the initial period. The weights are the outputs of individual plants expressed in terms of standard durability and discounted over the period from making the plant operational to the initial period, at a rate equal to the rate of growth a (e.g. 7%).

this assumption instead of formula (19) we have

$$E_{\text{progr}} = \frac{P_1 Z_{n_1} \dfrac{\frac{1}{T} I_1 + K_1 Y_{n_1} + S_1 Z_{n_1}}{P_1 Z_{n_1}} + \dfrac{P_2 Z_{n_2}}{(1+a)^{t_2 - t_1}} \dfrac{\frac{1}{T} I_1 + K_{2,1} + S_2 Z_{n_2}}{P_2 Z_{n_2}}}{P_1 Z_{n_1} + \dfrac{P_2 Z_{n_2}}{(1+a)^{t_2 - t_1}}}$$

Furthermore, in this case

$$E_1 = [(1/T)I_1 + K_1 Y_{n_1} + S_1 Z_{n_1}]/P_1 Z_{n_1}$$

and

$$E_2 = [(1/T)I_1 + K_2 Y_{n_2} + S_2 Z_{n_2}]/P_2 Z_{n_2}$$

Hence, formula (20) continues to be valid.

One of the more important applications of the formula for E_{progr} is the determination of stages in completion of investment. The individual segments of the formula's numerator and denominator then apply to successive stages of a given investment project.

8. So far, we have tacitly assumed that durability periods $n_1, n_2, \ldots, n_k$ are given. In reality this is more complicated. The efficiency of a single plant is determined by a formula $E = [(1/T)I + KY_n]/PZ_n$ which reaches its minimum at a certain value of n. It is this value of n which has to be taken as the durability period, and the value of E which corresponds to it has to be regarded as the coefficient of efficiency.[4] However, if the optimum period is longer than the durability period determined by such factors as physical use, lack of raw materials, etc., then it is this shorter period which should be taken into account in our calculations.

As long as durability periods of individual plants, $n_1, n_2, \ldots, n_k$ are independent from each other, they can be used in formula (20), which determines the efficiency of the investment programme, with such values which optimize the individual coefficients of efficiency: $E_1, E_2, \ldots, E_k$.[5] However, if durability periods of individual plants are in one way or another interdependent, the problem becomes much more complicated. Indeed, the values of $n_1, n_2, \ldots, n_k$ must then be determined through minimization of the coefficient E_{progr} (with which they are in a functional relation), while still taking account of their interdependence.

Let us explain this in an example. Let us suppose that a given investment project is completed in two stages. Let us denote the coefficient of its efficiency as E_{stage}. We have the formula

$$E_{\text{stage}} = \frac{P_1 Z_{n_1} E_1 + \dfrac{P_2 Z_{n_2}}{(1+a)^{t_2}} E_2}{P_1 Z_{n_1} + \dfrac{P_2 Z_{n_2}}{(1+a)^{t_2}}}$$

[4] See M. Rakowski, 'Durability Period in the Formula of the Efficiency of Investment', *Gospodarka Planowa*, 16/10 (1961) [in Polish].

[5] Even this procedure is not exact since the values of $n_1, n_2, \ldots, n_k$ affect not only the coefficients $E_1, E_2, \ldots, E_k$, but also their weights. Hence, their minimization does not lead to strict minimization of E_{progr}. However, if the minimum values of $E_1, E_2, \ldots, E_k$ are not much different from each other, then the resulting error is small.

If investment completed at the second stage can continue normal operation after the scrapping of the investment completed at the first stage, then n_1 and n_2 are mutually independent and they can be found, just like E_{stage}, through the minimization of E_1 and E_2.[6] However, if investment of the second stage can last only as long as it is sustained by the effects of investment of the first stage, then we must take into account the relation: $n_2 + t_2 = n_1$. We can then determine n_1 and n_2, respecting their interdependence, from the condition E_{stage}. This minimum is then the coefficient of efficiency of investment completed in stages.

[6] In approximation; see n. 5

The Problem of the Optimum Structure of Consumption[1]

(1963)

1. In connection with the recent development of linear programming methods and of the application of mathematical machines, the problem of the optimization of national income is now frequently discussed. If, in addition to the rate of growth of the national income, a given structure of consumption is assumed, the optimization of the national income in a long-run plan will eventually lead to the choice of the most efficient production techniques and to the most efficient structure of foreign trade. However, if no a priori assumptions are made about the structure of consumption and this component of the national income is also subject to optimization, this procedure will lead to perverse results if national income is expressed in constant prices, e.g. 1960 prices. Indeed, the maximum ratio of the value of consumption to its costs of production is rendered by the consumption structure, concentrating on that particular commodity for which the ratio of its price (say, of 1960) to its cost is highest. If, for instance, razor blades proved to be the most 'profitable' commodity in the above sense, the 'optimum' consumption structure would consist of this one particular commodity; obviously, this would be absurd.

2. This paradox is the result of a wrong definition of the equivalence of two variants of consumption that is based on the equality of their values in terms of those constant prices which are adopted as 'basic'. It is obvious, however, that, in fact, the actual consumption of a given year cannot be considered equivalent to the consumption of razor blades that is equal to it in value in terms of 'basic' prices. Even if variants not so drastically different are compared, the definition of equivalent consumption calculated in constant prices leads to obvious contradictions.

Let us denote by A the set of commodities consumed in the given year, and by B another set of commodities equal to it in value expressed in prices at which the set A was realized. Let us imagine that we maintain that A is equivalent to B. Let us assume, moreover, that in the next year the set B is supplied to the market. The realization prices will obviously be different because of a different structure of supply. Now, if we express the value of A in prices at which B was sold, the values of two sets will no longer be equal, inasmuch as two sets of commodities, whose values are equal in one price system, will not be equal in another one.

This can be illustrated by the following simple example.

Consumption is composed of only two commodities: 1 and 2. Their respective quantities and prices will be denoted by q_{1A}, q_{2A}, p_{1A}, p_{2A} for the set A, and q_{1B}, q_{2B}, p_{1B}, p_{2B} for the set B. The value of consumption at prices at which set A was realized is, in the case of this set, $p_{1A} \cdot q_{1A} + p_{2A} \cdot p_{2A}$ and, in the case of set B, $p_{1A} \cdot q_{1B} + p_{2A} \cdot q_{2B}$. By assumption these two values are equal. Hence

$$p_{1A} \cdot q_{1A} + p_{2A} \cdot q_{2A} = p_{1A} \cdot q_{1B} + p_{2A} \cdot q_{2B}$$

and, consequently,

$$p_{1A}(q_{1A} - q_{1B}) = p_{2A}(q_{2A} + q_{2B})$$

or

$$\frac{q_{2A} - q_{2B}}{q_{1A} - q_{1B}} = -\frac{p_{1A}}{p_{2A}} \tag{1}$$

This is the condition for the two sets, A and B, to be equivalent. But as the structure of B is different from that of A, the proportion of realization prices is also different. We thus have

$$\frac{p_{1A}}{p_{2A}} \neq \frac{p_{1B}}{p_{2B}}$$

Hence

$$\frac{q_{2A} - q_{2B}}{q_{1A} - q_{1B}} \neq -\frac{p_{1B}}{p_{2B}}$$

It follows directly that

$$p_{1B} \cdot q_{1A} + p_{2B} \cdot q_{2A} \neq p_{1B} \cdot q_{1B} + p_{2B} \cdot q_{2B}$$

This shows that the value of A and B is no longer equal when it is expressed in realization prices of set B.

3. There is, however, one case when this contradiction does not arise, namely when the structure of the set B is very similar to

that of A, i.e. when $q_{1B} = q_{1A} + \Delta q_{1A}$ and $q_{2B} = q_{2A} + \Delta q_{2A}$, where Δq_{1A} and Δq_{2A} are very small. Indeed, the changes in the prices will then be very small as well

$$p_{1B} = p_{1A} + \Delta p_{1A} \quad \text{and} \quad p_{2B} = p_{2A} + \Delta p_{2A}$$

Relation (1), expressing the condition for the equality of values of A and B in terms of the realization prices of A, can now be written as follows

$$\frac{\Delta q_{2A}}{\Delta q_{1A}} = -\frac{p_{1A}}{p_{2A}} \tag{2}$$

The condition for the equality of the values of A and B in terms of realization prices of B would be as follows:

$$\frac{\Delta q_{2A}}{\Delta q_{1A}} = -\frac{p_{1A} + \Delta p_{1A}}{p_{2A} + \Delta p_{2A}} \tag{3}$$

The ratio $\frac{p_{1A} + \Delta p_{1A}}{p_{2A} + \Delta p_{2A}}$ differs from $\frac{p_{1A}}{p_{2A}}$ only by a very small quantity ε. The two criteria of equivalence practically coincide here. This may best be seen if formulae (2) and (3) are rewritten as follows

$$\Delta q_{2A} = -\frac{p_{1A}}{p_{2A}} \Delta q_{1A}$$

and

$$\Delta q_{2A} = -\frac{p_{1A}}{p_{2A}} \Delta q_{1A} - \varepsilon \Delta q_{1A}$$

where $\varepsilon \Delta q_{1A}$ is a small quantity of the second order which may be neglected.

A new approach to the problem of equivalent consumption structures emerges here. From the consumption structure q_{1A}, q_{2A} (with realization prices p_{1A} and p_{2A}), we proceed to another very close structure ($q_{1A} + \Delta q_{1A}$, $q_{2A} + \Delta q_{2A}$), for which $\Delta q_{2A} = -(p_{1A}/p_{2A}) \cdot \Delta q_{1A}$. The prices in the new situation are $p_{1A} + \Delta p_{1A}$, $p_{2A} + \Delta p_{2A}$. We proceed according to the same principle, namely that the increments of the two commodities have different signs and that they are inversely proportional to current market prices. Through such a chain of equivalent consumption structures we may pass from the set $A(q_{1A}, q_{2A})$ to the set $B(q_{1B}, q_{2B})$, the differences $q_{1B} - q_{2A}$ no longer being very small. If we move backwards through this chain of equivalent consumption structures, we shall reach the set $A(q_{1A}, q_{2A})$. Indeed, when the consecutive steps are retraced on the way from B to A, the increment Δq_{2A} will differ from the corresponding increment on the way from A to B (apart from the sign) only by a small quantity of the second order $\varepsilon\Delta q_1$. The sum of these small quantities of the second order for the whole passage from B to A will be a small quantity of the first order. Hence, using this procedure, we shall 'land' with any degree of approximation in $A(q_{1A}, q_{2A})$. We do not encounter difficulties here similar to those that arose when we tried to define the equivalence of A and B as equality of values in terms of the realization prices of either of them.

We now shall present the chain AB diagrammatically. Although our argument will still refer to two-commodity sets, it may be generalized for a multi-commodity case.

4. Let us plot on the abcissa axis q_1 the quantity of the commodity 1 and, on the ordinate axis q_2, the quantity of the commodity 2. A point on the plane q_1, q_2 corresponds to a set of these two commodities. Point A denotes, for instance, the set A. Now, let q_1 be increased gradually from $0C$ to $0D$. Small changes Δq_2 are related to small changes Δq_1 as follows:

$$\frac{\Delta q_2}{\Delta q_1} = -\frac{p_1}{p_2} \tag{4}$$

where p_1/p_2 denotes the relation of the prices corresponding to the set A. The curve AB obtained in the course of this process is

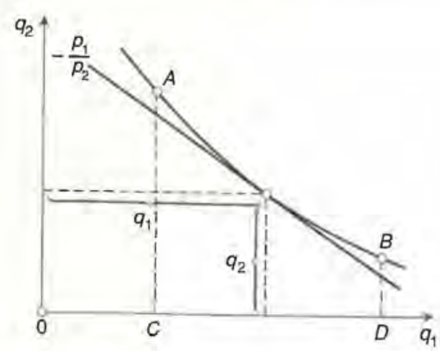

FIG. 31 *The transition from consumption structure* A *to consumption structure* B

declining (increments Δq_2 are negative), and the slope of its tangent at the point (q_1, q_2) is equal to $-p_1/p_2$ (see Fig. 31).

It follows from the above definition that the points on the curve AB represent equivalent sets of consumer goods. It may also be assumed that, when moving along the curve AB from A to B, the ratio p_1/p_2 decreases since the sales q_1 of the commodity 1 increase and the sales q_2 of the commodity 2 decline. Thus, the absolute value of the slope of the tangent (equal to p_1/p_2) decreases when we are moving from A to B. Therefore, the curve is concave.[1]

The curve AB constructed above has the same characteristics as the indifference curve familiar in Western economics. The latter, however, is derived from quite different premisses. The indifference curve represents an aggregate of the sets of two commodities q_1 and q_2, considered as equivalent by the *consumers*. The fact that the slope of the tangent at the point (q_1, q_2) is equal to $-p_1/p_2$ (where p_1 and p_2 are the realization prices of this set) is deduced from the assumption of an optimum consumer choice. This theory raises a number of conceptual objections.[2]

Our premisses are quite different in character: we simply try to find a definition of equivalence which eliminates the contradictions arising when sets of consumer goods are compared by valuing them at constant prices. The equality of the slope of the tangent at the point q_1, q_2 to $-p_1/p_2$ follows directly from our definition.

5. We may now proceed to the main subject of the paper, i.e. to the problem of choosing from all the sets of commodities 1 and 2 equivalent in the sense of the above definition that set which involves the least costs of production.

Let us denote by E_1 and E_2 the long-run costs per unit of output (including the cost of capital) such as are used in the valuation of the efficiency of investment.[3] The aggregate costs (in this sense)

[1] The differential equation of the curve AB can be derived as follows: p_1/p_2 is a function of q_1 and q_2 which we shall denote by f. Using equation (4), we may therefore write

$$\frac{\Delta q_2}{\Delta q_1} = -f(q_1, q_2)$$

[2] See I. M. D. Little, *A Critique of Welfare Economics*, Oxford, Oxford University Press, 1957.

[3] See *Instrukcja ogólna w sprawie badań ekonomicznej efektywności inwestycji* (General Instruction on the Methodology of Analyses of the Economic Efficiency of Investment), Warsaw, Komisja Planowania przy Radzie Ministrów, 1962.

of producing the set (q_1, q_2) is equal to $E_1 \cdot q_1 + E_2 \cdot q_2$. This value may be obtained diagrammatically as in Fig. 32.

Let us draw a straight line of a slope $-E_1/E_2$ through the point $M(q_{1M}, q_{2M})$ (see Fig. 32). It will easily be seen that $E_1q_{1M} + E_2q_{2M} \neq E_2b$, where b is equal to the distance $0N$ from the origin 0 of the point of intersection of NM with the ordinate axis. Indeed, the equation of the straight line NM is

$$q_2 = -E_1/E_2 \cdot q_1 + b$$

and since NM passes through the point (q_{1M}, q_{2M}), we have

$$q_{2M} = -E_1/E_2 \cdot q_{1M} + b.$$

Hence

$$E_1 \cdot q_{1M} + E_2 \cdot q_{2M} = E_2 \cdot b$$

The line MN will be called the straight line of production costs.

We can now find the variant of consumption which involves the least production costs. It is easy to show that it will correspond to the point R at which the straight line RS of production costs of a slope $-E_1/E_2$ is tangent to the curve AB of equivalent consumption variants (see Fig. 33).

Indeed, if the straight line of production costs passes through any other point of the curve AB—say, W—then it will cut a larger segment on the axis of the ordinates $(0V > 0S)$; this means that with the given unit production costs E_1 and E_2, the aggregate costs of producing q_{1W}, q_{2W} are greater than those of producing q_{1R}, q_{2R}.

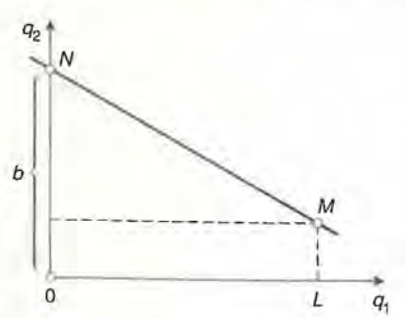

FIG. 32 *The change in the aggregate production costs of two commodities with a given ratio of unit costs and a changing structure of consumption*

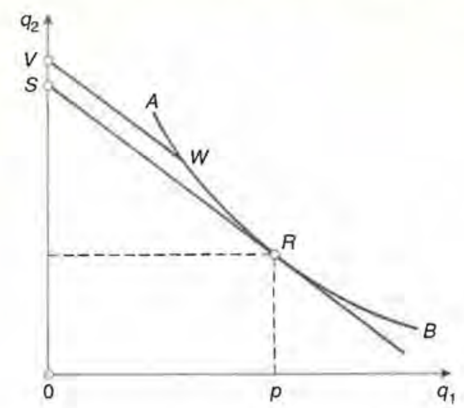

FIG. 33 *The determination of the output of two commodities that minimizes their aggregate costs of production*

This means, therefore, that the aggregate costs are at their minimum at the point R.

Let us recall that the slope of the tangent at the point R is equal to $-p_{1R}/p_{2R}$. It follows that at the point R the ratio of the realization prices must be equal to the ratio of unit costs

$$\frac{p_{1R}}{p_{2R}} = \frac{E_1}{E_2}$$

or

$$\frac{p_{1R}}{E_1} = \frac{p_{2R}}{E_2}$$

This shows that for the consumption variant characterized by the lowest level of production costs, the realization prices are proportional to the unit costs of production.

6. Thus far, we have considered sets of two commodities. In practice, we have to deal with sets composed of numerous goods. In this case, too, we may determine (theoretically) the aggregate of the sets of commodities equivalent to a given one by using the rule that two slightly different sets should have the same value in terms of the realization prices of one of them. Because the realization prices of these two sets differ only slightly as well, their values—neglecting small quantities of the second order—will also be equal in terms of the realization prices of the second set. These sets, which are close to each other, do not make a chain represented by the line AB as was the case for two commodities. If the number of the commodities is n, then the points in the n-dimensional space corresponding to the equivalent sets are situated on an $n-1$-dimensional surface.

Under some assumptions, the rule that the consumption variants involving the lowest level of the costs is characterized by a proportionality of the market realization prices $p_{1R}, p_{2R}, \ldots, p_{nR}$ to the unit production costs $E_1, E_2, \ldots, E_n$ applies in this general case as well.

Let us imagine an initial variant A for which market prices are not proportional to the unit costs. This cannot be the variant involving the least production costs, because their level can be decreased by moving to the nearby equivalent variant A' for which the weight of the more 'profitable' commodities is greater than in the variant A. Indeed, the value of the set A', in terms of prices $p_{1A'}, p_{2A'}, \ldots p_{nA'}$ is—according to the definition of equivalent variants—the same as that of the set A, but the aggregate costs are lower since commodities for which the ratio of P_A/E is relatively high have greater weight than in the set A.

We may proceed in this direction until—through the decline in the prices of the more 'profitable' commodities in relation to those of less 'profitable' ones—the proportions of realization prices are equated to the proportions of unit costs. (We assume that the process proceeds just in this way.) At this point R it is no longer possible to modify the set of commodities in a way that would reduce the aggregate production costs.

7. The question arises as to how one can, in practice, use this criterion of optimization of the structure of consumption from the point of view of the level of production costs.

Let us assume that a multi-commodity set A and its realization prices $p_{1A}, p_{2A}, \ldots, p_{nA}$ are given. The problem is to find another set, equivalent to the former in the sense of the above definition and whose realization prices are proportional to the unit costs $E_1, E_2, \ldots, E_n$. This would require, first, establishing the coordinates of numerous points of the $n-1$-dimensional surface mentioned above. The next step would be to find the point at which the realization prices proportional to $E_1, E_2, \ldots, E_n$ correspond. It is obvious that such a procedure is impracticable. It is therefore

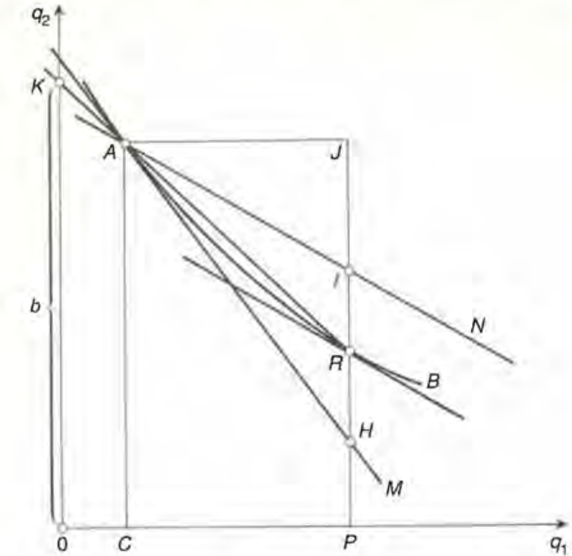

FIG. 34 *The general scheme for determining the optimal consumption variant*

necessary to consider some radical simplifications. For this purpose, let us again turn to the two-commodity scheme.

Let us draw the curve of equivalent consumption variants AB (see Fig. 34). We assume A to be the initial set for which the prices p_{1A} and p_{2A} are known. The slope of the tangent AM at this point is equal to $-p_{1A}/p_{2A}$. R is the point for which the aggregate costs are lowest, the slope of the tangent to the curve AB at this point being equal to $-E_1/E_2$. Let us now draw through the point A a straight line AN parallel to this tangent. H and I denote, as will be seen from the graph, the points of intersection of the lines AM and AN with the ordinate of the point R. Now it is known that if AR represents an arc of a parabola with a vertical axis, then R is situated in the middle of HI. Let us assume (which is plausible) that the curve AB can be approximated by such an arc and that, thus, R lies not far from the middle of the segment HI. We thus obtain as a good approximation

$$\frac{JR}{AJ} = \frac{1}{2} \cdot \left(\frac{JI}{AJ} + \frac{JH}{AJ}\right)$$

But JI/AJ is equal to E_1/E_2 and JH/AJ is equal to p_{1A}/p_{2A}. Hence

$$\frac{JR}{AJ} = \frac{1}{2} \cdot \left(\frac{E_1}{E_2} + \frac{p_{1A}}{p_{2A}}\right)$$

We shall resort to one more approximation, substituting for the arithmetic mean of E_1/E_2 and p_{1A}/p_{2A} their geometric mean (which is admissible when the ratios E_1/E_2 and p_{1A}/p_{2A} do not differ too much, i.e. when one of them does not exceed, say, twice the value of the second one). We then obtain

$$\frac{JR}{AJ} = \sqrt{\left(\frac{E_1 \cdot p_{1A}}{E_2 \cdot p_{2A}}\right)}$$

The slope of the line AR, which is equal to $-JR/AJ$, amounts approximately to

$$-\sqrt{\left(\frac{E_1 \cdot p_{1A}}{E_2 \cdot p_{2A}}\right)}$$

The equation of the straight line AR is therefore

$$q_2 = -\sqrt{\left(\frac{E_1 \cdot p_{1A}}{E_2 \cdot p_{2A}}\right)}(q_1 + b)$$

where b is equal to the segment $0K$.

Since the points A and R are on the same straight line, we have

$$\sqrt{(E_1 \cdot p_{1A})}(q_{1A}) + \sqrt{(E_2 \cdot p_{2A})}(q_2) = b\sqrt{(E_2\, p_{2A})}$$
$$= -\sqrt{(E_1\, p_{1A})}(q_{1R}) + \sqrt{(E_2\, p_{2A})}(q_{2R})$$

This equation means that the values of the sets A and R, in terms of prices $\sqrt{(E_1 \cdot p_{1A})}$ and $\sqrt{(E_2 \cdot p_{2A})}$, are approximately equal. In other words, the value of the set R, in terms of the prices $\sqrt{(E_1 \cdot p_{1A})}$ and $\sqrt{(E_2 \cdot p_{2A})}$, i.e. in terms of the geometric means of realization prices of the set A and the unit costs, is equal (approximately) to the value of the set A in terms of these prices G_A

$$G_A = q_{1R}\sqrt{(E_1 \cdot p_{1A})} + q_{2R}\sqrt{(E_2 \cdot p_{2A})}$$

This is the first (approximate) condition for the optimum consumption variant. The second condition is the proportionality of the realization prices of the set R to unit costs E_1 and E_2. Thus,

we now have to deal with a rather typical problem of the structure of consumption. The 'real' value of consumption, i.e. its value in constant prices—in prices $\sqrt{(E_1\, p_{1A})}$ and $\sqrt{(E_2\, p_{2A})}$—is given as well as the realization prices (which are here proportionate to unit costs E_1 and E_2), and the quantities q_{1R} and q_{2R} of the two commodities are to be determined. This requires, of course, a knowledge of the relationship between the consumption of one of them—say, q_{1R}, on the one hand—and the 'real' value of the aggregate consumption G_A, as well as the price ratio p_1/p_2 on the other.

8. It seems possible to use the same method in the case of multi-commodity sets as well: in this case, too, the value G_A of the initial set A, in terms of prices that are geometric means of the realization prices of the set A and of the unit costs, is likely to be roughly equal to the value of the optimum variant R in terms of these prices. We should therefore have

$$G_A = q_{1R}\sqrt{(E_1\, p_{1A})} + q_{2R}\sqrt{(E_2\, p_{2A})} + \ldots + q_{nR}\sqrt{(E_n p_{nA})}$$

This hypothesis has yet to be confirmed. Should it prove correct, the (approximate) determination of the consumption pattern involving the minimum aggregate costs in long-run planning could be carried out as follows:

The initial structure of consumption A—e.g. in 1980 expressed in 1960 prices—is established on the basis of family budgets corresponding to per capita income postulated for 1980. These prices will therefore be $p_{1A}, p_{2A}, \ldots, p_{nA}$ since they are realization prices corresponding to the actual consumption structure in 1960 as reflected in the family budgets. Furthermore, we determine the unit costs $E_1, E_2, \ldots, E_n$ according to the principles of the calculus of the efficiency of investment.

The next step is to calculate the value G_A of the set A in terms of the prices $\sqrt{(E_1\, p_{1A})}, \sqrt{(E_2\, p_{2A})}, \ldots, \sqrt{(E_n\, p_{nA})}$. Finally, we try to find such a set R of commodities $q_{1R}, q_{2R}, \ldots, q_{nR}$ whose value, measured in terms of prices $\sqrt{(E_1\, p_{1A})}, \sqrt{(E_2\, p_{2A})}, \ldots, \sqrt{(E_n\, p_{nA})}$, is equal to G_A and whose realization prices are proportionate to $E_1, E_2, \ldots, E_n$. Such a procedure requires, of course, a knowledge of the relationship between the consumption of a given commodity, on the one hand, and the 'real' value of aggregate consumption G_A, as well as the structure of prices, on the other.

9. We have not taken into account the possible ceilings for the consumption of particular commodities due to health, cultural, and other reasons. If in the optimum variant the consumption of respective commodities is below these limits, no modifications in the procedure will be required. Otherwise, corrections will prove necessary. This problem is, however, beyond the scope of this paper, the main purpose of which was merely to outline the general approach to the problem of the structure of consumption involving lowest production costs.

However, it is clear even at this stage that there is still quite a lot to be done before mathematical machines will begin to compute the optimum consumption structure. Both with regard to theory and availability of statistical data, we are still very remote from being able to 'feed' the electronic computers adequately. And until we have made substantial progress in these directions, the machines—as in many other problems—will merely be reducing to absurdity our immature ideas.

The Curve of Production and the Evaluation of the Efficiency of Investment in a Socialist Economy[1] (1965)

1. Choice of Technique

An increment of the national income of a given volume and structure in terms of final products, resulting from new investment, may be achieved by a variety of techniques. Each of the variants will involve a different outlay on investment I and a different amount of labour force R indispensable to run the newly created productive capacities. As the increment of the national income consists of many final products and each of them may usually be produced by different methods, a great number of variants comes into the picture. If we denote by N the number of groups embracing kindred products (we shall call them below commodity groups) and if for each only two variants are considered, there will be altogether 2^N variants of producing a given increment of the national income.

If one of the variants involves a greater investment outlay than another, while the labour force is the same or greater, this variant is absolutely ineffective. The same applies to a variant for which the labour force is greater and the investment outlay no less than in another case. We shall discard all the absolutely ineffective variants and shall consider only those in which a greater investment outlay is associated with a lesser labour force or vice versa.

Let us represent all these variants by a diagram, on which we plot the aggregate investment outlay I on the abscissa and the labour force R associated with it on the ordinate axis (see Fig. 35). To each of the variants there corresponds a point in the plane I, R. It follows from the above that the downward-sloping curve MN corresponds to the set of acceptable variants. Indeed, to each I there corresponds only one value of R, namely that of a variant where the investment outlay I is associated with the least labour force. Moreover, the curve is downward sloping because greater

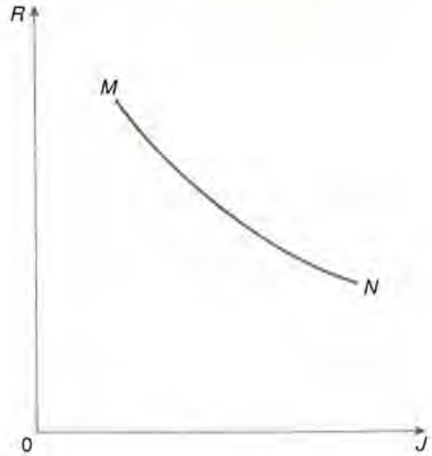

FIG. 35

investment outlays are associated with lesser labour force. The line MN is called the curve of production.

2. The Appropriate Criterion

This concept is clearly based on the assumption of a uniform labour force and of an equal life-span for all types of equipment, since only in such a case can a given variant be fully characterized by the investment outlay and the labour force associated with it. We shall deal in the final part of this paper with the problems arising when these simplifications are discarded. But even taking these assumptions for granted this approach to the curve of production may raise some reservations. Indeed, the central planning authorities are obviously unable to consider the enormous number of possible variants of producing an increment of the national income in order to eliminate those which are absolutely ineffective. Thus the curve of production appears to be purely theoretical in character since its points are not necessarily realized in practice (i.e. it is not excluded that an absolutely ineffective variant may be selected). We shall show, however, that this problem does not arise if the evaluation of efficiency of investment for any commodity group is based on the criterion

$$\frac{i}{T} + k = \min$$

where i is the investment outlay integrated over all stages of production, k the integrated current costs (exclusive of depreciation), and T the so called recoupment period. Indeed, we shall prove that to a given T there corresponds a point situated on the curve of production. It should be pointed out that, on the assumption of a uniform labour force and an equal life-span for all types of equipment, the simple condition

$$\frac{i}{T} + k = \min \tag{1}$$

is an appropriate criterion for the choice of variants.

We shall assume that in the case where the 'joint investment and labour outlay' $(1/T) + k$ is equal for two variants the less capital-intensive one is chosen, i.e. that with a smaller i.

We denote by i_w and k_w the investment outlay and the costs of the variant of production selected for a given commodity group and by i and k these characteristics of any variant for this group. We have then

$$\frac{i_w}{T} + k_w \leqslant \frac{i}{T} + k$$

By adding these equations for the economy as a whole we obtain

$$\sum\left(\frac{i_w}{T} + k_w\right) \leqslant \sum\left(\frac{i}{T} + k\right)$$

or

$$\frac{1}{T}\sum i_w + \sum k_w \leqslant \frac{1}{T}\sum i + \sum k \tag{2}$$

$\Sigma\, i_w$ and $\Sigma\, k_w$, however, are nothing else but the aggregate investment outlay I_w and the aggregate costs K_w required for a given increment of the national income by the adopted methods, while $\Sigma\, i$ and $\Sigma\, k$ are the aggregate values I and K for any 'aggregate variant'. We have thus

$$\frac{I_w}{T} + K_w \leqslant \frac{I}{T} + K \tag{3}$$

It follows directly that the point I_w, K_w cannot correspond to an absolutely ineffective variant. Indeed, if I_w were, for instance, greater than I' of a certain other variant, and K_w would not be less than K', we could write

$$\frac{I'}{T} + K' < \frac{I_w}{T} + K_w$$

which would contradict the inequality (3).

Let us denote now the hourly wage by g. To the aggregate costs K_w there corresponds a labour force $R_w = K_w/g$. It follows from the above that the point I_w, R_w is situated on the curve of production, because the latter represents all the 'effective' variants of producing a given increment of the national income (i.e. all variants which are not absolutely ineffective).

I_w, R_w is a point on the curve of production corresponding to a given period of recoupment T; it will be noticed that the greater T is, the farther to the right on the curve of production the corresponding point I_w, R_w is situated, because a higher recoupment period 'lets in' the more capital-intensive and less labour-intensive variants for particular commodity groups. However, we shall not be satisfied with this rather intuitive argument, but shall prove the theorem rigorously; at the same time we shall demonstrate that the curve of production is concave (as in Fig. 35).

3. The Curve of Production

Let us start with a diagrammatic representation of the variants of production of a given commodity group, plotting the investment outlays i on the abscissa and the current costs k on the ordinate axis.

If the recoupment period is T, it will be noticed that the best variant is determined by the point through which passes the lowest of the straight lines of a slope $-i/T$. Indeed, the equation for the straight line of such a slope is

$$k = -\frac{i}{T} + b$$

where b is the distance of the point of intersection of this straight line with the ordinate axis from the zero point. Thus

$$\frac{i}{T} + k = b$$

and the condition for the best variant is

$$\frac{i}{T} + k = b_{\min}$$

It follows directly that there must be chosen such a point i, k through which passes a straight line with the least b. It follows, moreover, that at no T does the point C come into consideration and we are left only with A, B, and D situated on the lower concave boundary to choose from. Let us denote now the recoupment periods corresponding to the slopes AB and BD by T_{AB} and T_{BD}. If $T = T_{AB}$, we shall choose the variant A; indeed for the variants A and B the value of the expression $(i/T) + k$ is the same and according to our rule we choose then the less capital-intensive variant. If $T_{AB} < T \leqslant T_{BD}$ we choose the variant B (the case represented in Fig. 36). Finally, when $T > T_{BD}$, the variant D will prove the best. In other words, when increasing the recoupment period T we pass the level T_{AB}, we shift from the variant A to a more capital-intensive and a less labour-intensive variant B. (If we pass the value T_{BD} we shift correspondingly from the variant B to the variant D.)

Let us consider now all the commodity groups, for which we may draw diagrams analogous to Fig. 36. Let us derive from each diagram the recoupment periods T corresponding to the segments

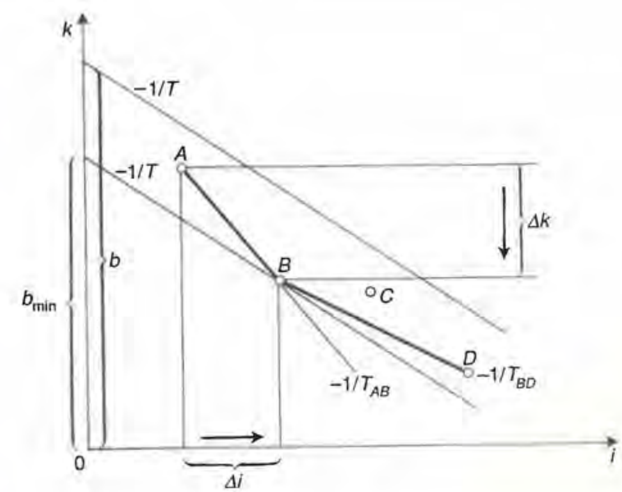

FIG. 36

of the lower concave boundary such as T_{AB} and T_{BD}. Let us range all these recoupment periods according to their length; we shall obtain an increasing sequence $T_1, T_2, \ldots, T_j, T_{j+1}, \ldots, T_m$. It should be noted that T_j may correspond to a number of commodity groups and that T_{j+1} may obviously correspond to other commodity groups than T_j.

Let us imagine that a recoupment period T_j has been adopted to which corresponds the point I_j, R_j on the curve of production and that next we pass from T_j to T_{j+1}. Then for the commodity groups, to which corresponds T_j this level of the recoupment period will be passed (for instance T_{AB} in Fig. 36) and, according to the above, a shift will occur for these commodity groups to the more capital- and less labour-intensive variants (for instance from variant A to variant B). As a result the value of the investment outlay in the economy as a whole will increase as well from I_j to the higher level I_{j+1}, and the labour force required will fall from R_j to R_{j+1}. Therefore the point I_{j+1}, R_{j+1} on the curve of production corresponding to T_{j+1}, will be situated to the right of and below the point I_j, R_j which corresponds to T_j (see Fig. 37).

Nor is that all. Indeed T_j corresponds to a side of the lower boundary of the set of points representing the variants on one or more diagrams relating to the particular commodity groups (for

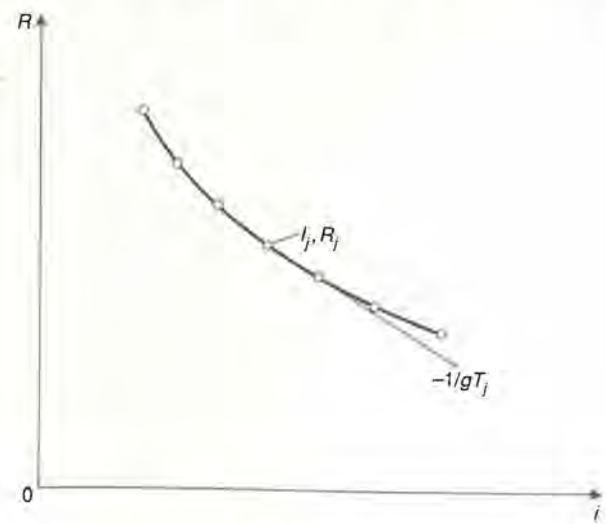

FIG. 37

instance AB in Fig. 37). When T_j is passed a shift occurs from the beginning of that side to its end (e.g. from A to B). Thus the respective increase in current costs Δk and investment Δi bear the relation $-I/T_j$ (e.g. the relation $-I/T_{AB}$), i.e.

$$\Delta k = -\frac{1}{T_j}\Delta i \tag{4}$$

Since just these increases constitute the increments of the aggregate investment outlay and of the aggregate costs, we obtain

$$K_{j+1} - K_j = -\frac{1}{T_j}(I_{j+1} - I_j) \tag{5}$$

and thus

$$R_{j+1} - R_j = -\frac{1}{gT_j}(I_{j+1} - I_j)$$

It follows directly that the straight line connecting the subsequent points I_j, R_j and I_{j+1}, R_{j+1} situated on the curve of production has a slope $-1/(gT_j)$. In other words, the segment starting from the point I_j, R_j has the slope $-1(gT_j)$ (Fig. 37). Consequently, the longer the recoupment period T_j, the more to the right is situated the corresponding point $I_i R_i$—which was already proved above—and the smaller the slope of the segment starting from this point. This means, however, that the line represented in Fig. 37 is concave.

If the points I_j, R_j are sufficiently close to each other, this line approaches the curve of production and the slopes of its sides—those of the tangents at these points. The tangent of the curve of production at the point I, R is consequently equal to $-1/gT$ and thus it is easy to read from the diagram the recoupment period corresponding to a given point. Because I increases together with T, the curve of production is concave (Fig. 38).

On the basis of the curve of production it is possible to determine the recoupment period corresponding to the assumed increment of the national income and to the labour force R_1 available for this purpose. Let us draw a curve of production for the assumed increase of the national income and let us find on it the point with the ordinate R_1; then the abscissa I_1 yields the value of the investment outlay required and the slope of the tangent at the point I_1, R_1—the recoupment period T_1 which must be applied

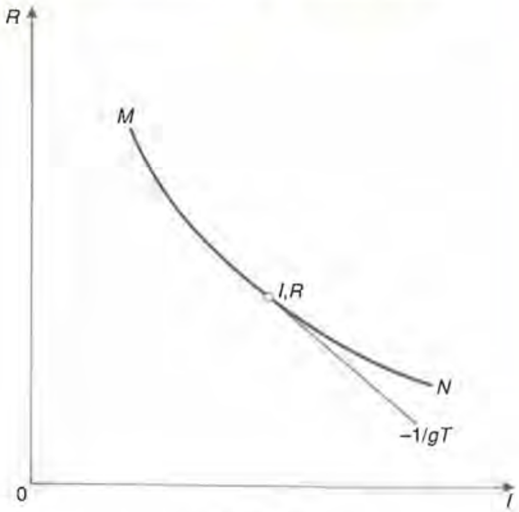

FIG. 38

in the evaluation of efficiency of investment for realizing the variant which corresponds to the point I_1, R_1, and thus for securing equilibrium in the balance of the labour force.

4. The Effect of Technical Progress

The above discussion is of some importance for the theory of growth because the curve of production is an essential element in the analysis of technical progress. The curve of production represents the set of 'effective' variants of producing an increment of the national income which are based on the technical knowledge at a given time. A change in this knowledge, i.e. technical progress, may be represented by a downward shift of the curve of production. Thus a reduction of labour which is required to produce a given set of goods takes place, i.e. an increase in the productivity of labour, which is not 'paid for' by an increase in capital intensity. This process is represented in Fig. 39, where MB is the curve of production at time t and $M'B'$ at time $t+1$. With an unchanged investment outlay $0A$ (valued at constant prices) the labour force required for producing a given increment of the national income declines from AB to AB', and the productivity of labour increases, of course, in the inverse proportion.

The slope of the tangent at point B' will in general be different from that at point B. Indeed, with an unchanged wage rate g to a given I there corresponds in general a recoupment period which is different at time $t+1$ from that at time t: as a result of the technical progress the variants for the particular commodity groups are transformed in the direction of the reduction of current costs associated with a given investment valued at constant prices; this reduction, however, varies considerably from asset to asset. In the case presented in Fig. 39, where all the ordinates of the curve of production decline in the same proportion (i.e. when productivity of labour shows an equal rate of increase for all the values of I), the slope of the tangent at point B' is reduced as compared with the slope of the tangent at point B in the relation AB'/AB; it follows directly that the recoupment period increases in this case in the same proportion as the productivity of labour.

In order to be able to present the technical progress, as above, it is essential to make sure that to a point on the curve of production there corresponds a real situation. As was pointed out, it cannot be assumed that the variant corresponding to this point is realized by central planning authorities discarding the absolutely ineffective variants. As has been shown, this point is realized by the evaluation of efficiency of investment at the lower echelons of economic management.

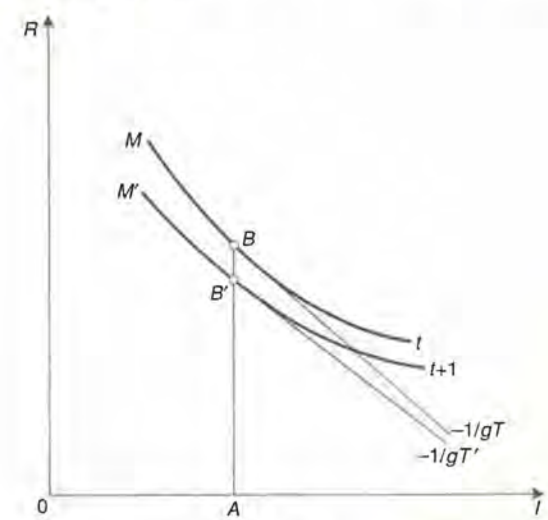

FIG. 39

In accordance with our assumptions we have postulated so far a rather simplified method of this evaluation. Let us enquire now what is the position when these simplifications are discarded and the methods of evaluation of the efficiency of investment which are actually applied in socialist countries are taken into consideration.

5. The Composition of the Labour Force

First of all the assumption that employment is proportionate to the wage bill must be abolished. Indeed, a shift from one production variant to another may involve a change in the proportion of better-paid employees and as a result the average earnings may change. Therefore the above argument applies, strictly speaking, only when the outlay of labour is measured by the ratio when $\Sigma\, k/g$, where g is the hourly wage of unskilled labour, rather than in man-hours. Thus instead of the labour force we should consider its equivalent in terms of unskilled labour calculated on the basis of wage relations. If when moving along the curve of production the average wage does not change significantly—which is quite likely within a limited range of I—the preceding discussion would apply approximately to the curve of production based on the number of man-hours.

The question may arise here, how should the quantity of labour be measured in the theory of growth: in actual man-hours or rather by the equivalent in man-hours of unskilled labour? The answer to this question is by no means simple and is outside the framework of this paper.

6. Differentiated Recoupment Periods

What will be the repercussions of the application of different recoupment periods for various commodity groups, as is the case for example in evaluation of the efficiency of investment in the Soviet Union? Let us assume that these recoupment periods bear a constant relation to each other, so that the recoupment period of the commodity group s may be represented as T/a_s, where a_s is a constant coefficient. As a result all recoupment periods change proportionately to T. The formula for evaluation of the efficiency of investment for the commodity s may be now written as follows

$$\frac{1}{T} a_s I + k = \min \tag{6}$$

From the course of our argument it follows directly that it would fully apply to a curve of production obtained by plotting on the abscissa axis the $\Sigma\, a_s i$ rather than $\Sigma\, i = I$. (This will be the sum of investment outlays weighted by coefficients a_s.) In general the curve of production obtained in this way will not be equivalent to the production curve constructed on the assumption of the same T for all commodity groups, when it is $\Sigma\, i = I$ that we plot on the abscissa axis. The variant of producing a given increment of the national income discarded as absolutely ineffective in one system, may be accepted in another.

There is nothing strange about this. Indeed, the system of differentiated recoupment periods aims at fostering the capital intensity in certain industries. Therefore whereas to a given aggregate cost $K = \Sigma\, k$ there corresponds in the system of one recoupment period for all commodity groups the least aggregate investment outlay $I = \Sigma\, i$—what is minimized in the system presently considered is the sum in which the investment in 'privileged' industries is more heavily weighted.

There arises the difficulty, however, that from the point of view of the theory of growth the sum $\Sigma\, a_s i$ is not a suitable variable, the actual investment outlays $I = \Sigma\, i$ being in the centre of discussion. This difficulty may be overcome by modifying the concept of the curve of production related, as previously, to the investment outlays I and the labour force R. The point I_j, R_j of this curve is now determined simply as that variant of producing a given increment of the national income which is obtained by the evaluation of efficiency of investment based on recoupment periods differentiated for particular commodity groups T/a_s for $T = T_j$. The fact that the investment outlay I_j will not now be necessarily the lowest of those associated with R_j does not interfere with the suitability of such a curve of production for the theory of growth. It is only important to check whether such a curve is downward sloping, because this *is* essential in the analysis of technical progress. We shall prove that this is the case.

When T is increased from T_j to T_{j+1} a shift to a more capital- and less labour-intensive variant takes place for one or more commodity groups. As a result the aggregate investment outlay increases from I_j to I_{j+1}, and the labour force decreases from R to R_{j+1}, i.e. the curve of production is downward sloping here as well. However it is impossible to prove in this case that the curve is concave. Indeed, formula (4) will now read as follows

$$\Delta k = -\frac{a_s}{T_j}\Delta i \tag{7}$$

Therefore the slope of the production curve $(R_{j+1} - R_j)/(I_{j+1} - I_j)$ is influenced not only by the magnitude of T_j, but also by the coefficients a_s of those commodity groups where a shift to a higher capital intensity occurred, when I increased from T_j to T_{j+1}. Since in the course of the further increase in T the shifts in the variants of other commodity groups with different coefficients a_s will be relevant, it is impossible to prove that the slope of the segment starting from I_j, R_j will decrease along with T. It is not certain, therefore, whether in this case the curve of production is concave. This however is not essential for the analysis of technical progress in the theory of growth.

7. Length of Life of the Equipment

We shall now consider the problem of different life-spans of various types of equipment. Let us start with the case where in evaluation of the efficiency of investment this is accounted for by differentiating the recoupment period T according to different rates of depreciation. (For instance, if the life-span amounts to 20 years for one asset and to 40 years for another and for the first asset $T = 6$ years and thus $1/T = 0.167$—then for the second asset we shall have $1/T = 0.167 - 0.050 + 0.025 = 0.142$, and thus T' amounts to about 7 years; it should be recalled that according to our assumption depreciation is not included in the current costs.)

This case is thus similar to the previously considered differentiation of the recoupment period between industries; and as in the other case the curve of production must be constructed on the basis of variants which are realized through the practice of evaluation of the efficiency of investment. Again to a given labour force R there will not correspond on this curve the least investment outlay, because apart from the capital and labour intensity of an asset its durability is taken into consideration as well.

As regards the proof that the curve of production is downward sloping, the position is more complicated here than for the differentiation of the recoupment period between industries; there exists a theoretical possibility in this case that for a particular commodity group the more capital- and more labour-intensive variant may prove 'better' because its much lower rate of depreciation would outbalance its higher capital and labour intensity. This is, however, unlikely. In practice more capital-intensive assets which are at the same time more durable require as a rule less labour. It may reasonably be assumed that when as a result of the increase in the recoupment period the more capital-intensive variants are 'let in' they are at the same time less labour-intensive. As a result the aggregate investment outlay of investment I increases with T and the aggregate labour force declines or the curve of production is downward sloping.

However—just as in the case of recoupment period differentiated between industries—it cannot be assumed that the curve of production is concave. For the relation of the decline in the labour force R to the increase in the investment outlay I accompanying the rise in the recoupment period is influenced by the depreciation rates of these variants of particular commodity groups between which occurs a shift in the direction of greater capital and lesser labour intensity.

In Soviet practice the two cases considered last overlap because the recoupment period is differentiated between industries and reflects the differences in depreciation rates. (In fact depreciation is included in current costs, but this amounts to the same as allowing for the difference in depreciation rates in the length of the recoupment period since depreciation is proportionate—at a given depreciation rate—to the investment outlay.)

8. The New Polish Approach

In the Polish methodology of evaluation of the efficiency of investment the recoupment period is not differentiated between industries, but up to 1960 the difference in the rates of depreciation was taken care of in the way described above. In the new methodology the approach to the problem of different life-spans is more complicated. We shall give here a general outline of this approach, with an emphasis on the points which are relevant to the problem of the curve of production.

The new approach based on a theoretical enquiry consists of allowing for the life-span of equipment through multiplying the investment outlays i and the current costs k by coefficients $f(n)$ and $\varphi(n)$ which are definite functions of n; thus 'joint investment and labour outlay' of a variant with a life-span n can be written as follows

$$\frac{i\,f(n)}{T} + k\ \varphi(n)$$

It must be added that f is a decreasing function, and φ an increasing one and that the above expression reaches its minimum at a certain value n. The value—depending on i and k—is thus the optimum life-span n_{opt}. It is this life-span that is accepted for evaluation of the efficiency of investment rather than that corresponding to a conventional norm of depreciation for a given type of equipment. Thus the 'joint investment and labour outlay' for a given variant is finally

$$\frac{i\,f(n_{\text{opt}})}{T} + k\varphi(n_{\text{opt}})$$

We thus have by definition the inequality

$$\frac{i\,f(n_{\text{opt}})}{T} + k\varphi(n_{\text{opt}}) \leqslant \frac{i\,f(n)}{T} + k\varphi(n) \tag{8}$$

where n is any life-span of the equipment considered.

Let us turn to our curve of production. We construct it, as in the cases previously discussed, on the basis of the variants i, k, selected for particular commodity groups by minimizing the 'joint investment and labour outlay'

$$\frac{i\,f(n_{\text{opt}})}{T} + k\varphi(n_{\text{opt}})$$

It has now to be proved that the curve of production is downward sloping. It appears that in this case no additional assumption is necessary, as contrasted with the previous approach to the influence of different life-spans of equipment. Indeed it may be proved here that a more capital intensive and no less labour-intensive variant is 'worse' for any recoupment period T.

Let us denote the investment outlay and the cost of a variant for some commodity group by i and k, and for a more capital-intensive variant by i' and k'. Let us further denote the optimum life-span of equipment for the first variant by n_{opt} and for the second one by n'_{opt}. Let us assume that although $i' > i$, we have $k' \geqslant k$. We can thus write

$$\frac{i\,f(n'_{\text{opt}})}{T} + k\varphi(n'_{\text{opt}}) < \frac{i'f(n'_{\text{opt}})}{T} + k'\varphi(n'_{\text{opt}})$$

(i.e. the first variant is 'better' if for both variants we apply the life-span of the second asset). We have next, according to formula (8)

$$\frac{i\,f(n_{\text{opt}})}{T} + k\varphi(n_{\text{opt}}) \leqslant \frac{i\,f(n'_{\text{opt}})}{T} + k\varphi(n'_{\text{opt}})$$

(i.e. it is better to use the first asset for n_{opt} years than for n'_{opt} years). But from these two inequalities it follows

$$\frac{i\,f(n_{\text{opt}})}{T} + k\varphi(n_{\text{opt}}) < \frac{i'f(n'_{\text{opt}})}{T} + k'\varphi(n'_{\text{opt}})$$

and thus the first variant is 'better' than the second for any value of T.

Therefore the more capital-intensive variants for particular commodity groups which are 'let in' as a result of the increase in T are less labour-intensive; thus the increase of the aggregate investment outlay will be accompanied by a reduction of the labour force associated with it, i.e. the curve of production is downward sloping. However, in this case, as in that previously considered, it cannot be maintained that the curve is concave.

9. Conclusions

To summarize: the evaluation of the efficiency of investment practised in socialist countries determines, given the level of the recoupment period (or periods), the investment outlay I and the labour force R required for producing a given increment of the national income. When the recoupment period is raised the investment outlay increases, and the labour requirements decline. Consequently the set of points I, R represents a downward-sloping curve, which we call the curve of production. If the same recoupment period T for all industries is accepted, the differences in the life-span of equipment are disregarded and the labour force is measured by the aggregate costs divided by the hourly wage g for unskilled labour—then the curve of production exhibits in addition the following characteristics: (i) to a given labour force R there corresponds the least investment outlay, (ii) the curve is concave, and (iii) the slope of the tangent in its point I, R, corresponding to the recoupment period T, is equal to $-i/gT$. The differentiation of the recoupment periods between industries, as well as allowing for the differences in the life-spans of equipment, deprives the curves of production of these characteristics because they introduce in the evaluation of variants new variables in addition to the investment and labour outlays. It is probable, however, that the actual curves of production can be fairly well approximated by curves possessing characteristics (i) and (ii).

Observations on Mieczysław Rakowski's Recent Approach to the Problem of Efficiency of Investment[1]

(1967)

1. In his article on 'Maximization of Economic Growth and Criteria of Efficiency of Economic Progress' Mieczysław Rakowski puts forward an idea which is rather critical of the basic formula used in the theory of efficiency of investment.[1] A close examination of his idea may help to dispel a number of misunderstandings and provide additional insight into some basic issues of this theory.

In his argument Rakowski often deals with issues which are discussed in my paper 'The Curve of Production and the Evaluation of the Efficiency of Investment in a Socialist Economy'.[2] (I am in no way implying that he borrowed some of my ideas since he probably did not know my paper.) For the sake of convenience, I shall start therefore with a short summary of the main points of my article, which I will then use in examining Rakowski's ideas.

2. The curve of production is defined in my article as a set of points I, R which represent alternative variants for producing an increment in national income of a given volume and structure, generated through the use of different combinations of investment outlay I and labour R. I discard variants which are absolutely ineffective, i.e. those involving greater investment outlay while the input of labour is the same or higher than in any other variant (or vice versa). We are therefore concerned only with those variants in which a greater investment outlay is associated with a lesser input of labour. From this it follows that the curve of production is downward sloping. Of course, this idea presupposes a uniform life-span for all types of equipment since only in such a case can a variant for producing a given increment in national income be fully characterized by the investment outlay and the labour input associated with it.

[1] See *Gospodarka Planowa*, 22/5 (1967) [in Polish].
[2] [See this volume.]

I then prove that 'if the evaluation of efficiency of investment for any commodity group is based on the criterion $(i/T) + k =$ minimum, where i is investment outlay integrated over all stages of production, k is the integrated current costs (exclusive of depreciation) and T is the so-called recoupment period [then] to a given T there corresponds a point situated on the curve of production.'[3]

Indeed, 'We denote by i_w and k_w the investment outlay and the costs of the variant of production selected for a given commodity group, and by i and k these characteristics of any variant for this group. We have then

$$(i_w/T) + k_w \leq (i/T) + k \tag{1}$$

By adding these equations for the economy as a whole we obtain

$$\Sigma\,[(i_w/T) + k_w] \leq \Sigma\,[(i/T) + k]$$

or

$$(1/T)\Sigma\, i_w + \Sigma\, k_w \leq (1/T)\,\Sigma\, i + \Sigma\, k \tag{2}$$

$\Sigma\, i_w$ and $\Sigma\, k_w$, however, are nothing else but the aggregate investment outlay I_w, and the aggregate costs K_w, required for a given increment of the national income by the adopted methods, while $\Sigma\, i$ and $\Sigma\, k$ are the aggregate values I and K for any "aggregate variant". We have thus

$$(i_w/T) + k_w \leq (1/T) + K \tag{3}$$

It follows directly that the point I_w, K_w cannot correspond to an absolutely ineffective variant. Indeed, if I_w were, for instance, greater than I' of a certain other variant, and K_w would not be less than K', we could write

$$(I'/T) = K' < (i_w/T) + K_w$$

which would contradict the inequality (3).

Let us denote now the hourly wage by g. To the aggregate costs K_w there corresponds a labour force $R_w = K_w/g$. It follows from the above that the point I_w, R_w is situated on the curve of production because the latter represents all the "effective" variants of producing a given increment of the national income (i.e. all variants which are not absolutely ineffective).

[3] [pp. 160–1 above.]

I_w, R_w is a point on the curve of production corresponding to a given period of recoupment T; it will be noticed that the greater T is, the further to the right on the curve of production the corresponding point I_w, R_w is situated, because a higher recoupment period "lets in" the more capital intensive and less labour-intensive variants for particular commodity groups.'[4]

I then consider in some detail the relationship between alternative variants for different commodity groups and the curve of production for the increment in the national income as a whole. For any given recoupment period T, the best variant for a given commodity group is determined by the point through which passes the lowest of the straight lines of a slope $-\,(1/T)$ since in this case $(i/T) + k = \text{min}$. It follows that for any T only those variants should be taken into consideration which are situated on the lower concave boundary of a set of points representing alternative variants. It is now easy to see that selecting, as we have previously done, in every commodity group the variant of $(i/T) + k = \text{min}$ for various T periods and summing the values of i and k selected for those T's, we are indeed summing up concave boundaries which correspond to the individual commodity groups. We thus obtain a concave curve of production for the national income as a whole. The tangent at its any given point is $-\,(i/T)$, where T is the recoupment period corresponding to this point.

Finally, I conclude that 'On the basis of the curve of production it is possible to determine the recoupment period corresponding to the assumed increment of the national income and to the labour force R_1 available for this purpose. Let us draw a curve of production for the assumed increase in the national income and let us find on it the point with the ordinate R_1; then the abscissa I_1 yields the value of investment outlay required and the slope of the tangent at the point I_1, R_1—the recoupment period T_1 which must be applied in the evaluation of efficiency of investment for realizing the variant which corresponds to the point T_1, and thus for securing equilibrium in the balance of the labour force.'[5]

It should be noticed that speaking of an increment in the national income I have in mind the production effect of new investment without deducing the losses due to scrapping of obsolete equipment; therefore, the supply of labour R includes not

[4] [pp. 161–2 above.] [5] [pp. 165–6 above.]

only its increase due to population growth, but also labour made available by shutting down obsolete plants. At a given durability period (assumed to be the same for all plants), the supply of labour from this source can also be strictly determined, however.

3. Let us now go back to Mieczysław Rakowski's paper. In my opinion, he enters into polemics with the use of the formula $(i/T) + k = \min$ in a rather unfortunate way. He starts his analysis with an extremely peculiar case of a one-sector economy in which for a given T all investment projects under consideration have the same value of $(i/T) + k$. All the points which represent different variants of production therefore lie on a single straight line whose slope is $-(1/T_0)$; this is the curve of production. It is clear that my argument summarized above does not apply to this case, although the argument is 'macroeconomic' in so far as it is based on a very realistic assumption that there exists a whole range of recoupment periods.

In fact, it can be demonstrated that in this case there does not exist a determined solution to the problem of choice of production variants. The point is that the given ratio of investment outlay to labour, which Rakowski assumes to be zł 250 000 per worker, can be achieved by many different combinations of production variants. This result can, for instance, be obtained through using variant 1 for 29% of the increment in the national income and variant 4 for the remaining 71%, but also by applying variant 2 for 44% of the increment of the national income and variant 4 for the remaining 56% or, finally, by opting in variant 3 for 87% of this increment and 13% in variant 4. Indeed, following his example we have an approximate equality of the ratios:

$$
\begin{aligned}
&(0.15 \times 160 + 0.85 \times 340)/(0.15 \times 2000 + 0.85 \times 800) \\
&= (0.44 \times 220 + 0.56 \times 340)/(0.44 \times 1600 + 0.56 \times 800) \\
&= (0.87 \times 280 + 0.13 \times 340)/(0.87 \times 1200 + 0.13 \times 800) \\
&= 0.25.
\end{aligned}
$$

(Rakowski obtains a different result by introducing an accelerated scrapping of obsolete equipment since he does not take into account the possibility of combinations of different variants; this makes the problem under examination more complicated and obscure.)

We are, therefore, dealing with a very special case in which not only the formula $(i/T) + k = \min$ cannot be applied, but also in which a unique optimum solution does not exist. Such a case is wholly irrelevant to reality. The assumption that in each industry points which represent different variants of production all lie on a single straight line, and that these lines have the same slope for every industry is pure fantasy. The problem of efficiency of investment is complicated enough not to make it even more so by examining freaks which shed no additional light on the essential problems, but rather obscure them. As we shall see, in the further course of his argument Rakowski departs from this criticism of the use of the $(i/T) + k = \min$ formula, however.

4. Let us now turn to Rakowski's concept, which he sees as contradicting the formula of $(i/T) + k = \min$ and the other similar formulae. The essence of his concept is the defining for individual industries their 'ordered functions' which relate investment outlay to employment; these functions are next summed up to obtain the aggregate function.

It is easy to see that these 'ordered functions' are akin to the lower concave boundaries of the set of points which represent different production variants in a given industry, put forward in my article on the curve of production. The formal difference, such as the fact that I plot investment outlay on the abscissa and the labour inputs on the ordinate, and Rakowski does the opposite is, of course, of no significance. However, there is also one essential difference between his approach and mine.

The points on my curves, as I have already mentioned, refer to new investments and the labour associated with them necessary to achieve a stipulated production effect, without making deduction for the output in plants which are being scrapped; hence employment also includes labour made available through the scrapping of obsolete plants. On the other hand, from Rakowski's argument it follows that his 'ordered functions' apply to the net increment in the national income, i.e. after subtracting the losses due to scrapping obsolete equipment. The demand for labour is therefore also conceived in net terms, i.e. after taking into account the supply of labour made available through scrapping. While my points on the curve of production represent different production variants for new plants, those of Rakowski's concept represent some combinations of different operations: scrapping of obsolete plants, their modernization, and investing in wholly new plants. This is an important difference since in distinction from the new plants all operations to be applied to the already existing capital equipment are not multiplicative. For instance, modernization which leads to an increment in a given output cannot by itself be considered as representing a single production variant since one may not be able to repeat it on a scale large enough to achieve the required increase in output. Taking this specific feature of modernization into account is in my opinion the most valuable contribution of Rakowski's approach.

However, it is rather unclear how his 'ordered functions' for different industries are aggregated. From a single sentence devoted to this subject one can deduce that the summing of investment and labour costs at those points on curves of production of individual industries which are characterized by the same recoupment period, i.e. at those points whose tangents to the curves of production for each industry are parallel to each other, is advocated. This seems to me to be the only method applicable in this case anyway. If so, then the aggregate 'ordered function' is constructed from industry functions in the same way as my curve of production which is derived from the lower concave boundaries of sets of points which represent production variants in the different commodity groups.

If this interpretation is correct, then it is easy to see that by selecting such a point on the curve of 'ordered function' for an industry which meets the condition of $(i/T) + k = \min$, and by summing up the selected values of i and k, we arrive at a point on the aggregate 'ordered curve' for a given recoupment period T. If this operation is carried out for all values of the recoupment period, the entire curve of production will thereby be constructed. Given the stipulated increment in the national income and in employment we can read from this curve what could be the lowest possible investment outlay. A line tangent to this aggregate curve at the point which represents this lowest investment outlay determines the recoupment period T, and thus also the variants which should be selected in the individual industries. Rakowski regards total investment outlay and growth in employment as given and maximizes the increment in the national income, which in fact comes to the same thing.

Thus it appears that Rakowski's concept by no means contradicts the use of the formula $(i/T) + k = \min$. However, its use should be limited to points of the 'ordered functions' for individual industries which, as I have mentioned, represent not only various technological variants for new investment, but also their combination with operations conducted on the already existing capital equipment. The recoupment period should be set at a level which assures equilibrium in the balance of labour. Furthermore, in my opinion this is the proper way to apply Rakowski's concept, and his own example of its application (in the table on p. 18 of his article) does not contribute to the proper explanation of the problem under consideration.

5. After this interpretation of the concept of the industrial 'ordered functions', their 'summing up', and the selection of variants in individual industries, I must also consider the admissibility of constructing these functions in the manner proposed by Rakowski. It appears that he excessively simplifies this problem by assuming that every combination of new plants and operations conducted on the already existing capital equipment can be represented by two variables only: investment outlay and labour. A huge part of work on 'The General Instruction on the Methodology of Analyses of the Economic Efficiency of Investment' consisted of taking into account differences in durability of the alternative variants; this issue was particularly important in the case of the choice between scrapping or modernization of the obsolete equipment. In fact, Rakowski's argument is correct only if a uniform durability of all equipment is assumed and modernization of plants is abstracted from. In this case, however, his argument wholly coincides with my argument on the curve of production. In fact, Rakowski writes that the problem of different durability periods is very complex and that at present he cannot offer a fully rational solution.

The outcome of our study can thus be formulated as follows: If we could construct the 'ordered functions' for individual industries, then the use of the $(i/T) + k = \min$ formula would by no means be unnecessary; it would only have to be modified. However, without taking account of different durability periods of different plants, such functions cannot be derived. Therefore, I cannot agree with Rakowski that his concept represents 'an important step ahead' in research on the efficiency of investment, although it is an interesting and useful contribution to the debate on this extremely complex topic.

It appears to me that further progress in this field could be reached through elaboration of formulae derived from those featured in 'The General Instruction,' even if they proved to be quite different from each other. If I am right, the recoupment period, set at a level corresponding to an equilibrium in the balance of labour and, at the same time, optimizing in a way investment outlay necessary to achieve the planned increment in the national income, would continue to be an integral element of calculation of the efficiency of investment. This is also supported by the above interpretation of Rakowski's concept.

Basic Problems in the Theory of the Efficiency of Investment[1] (1970)

1. A Simplified Model

1. Let there be a given closed national economy consisting of branches representing different stages in the production of an end-product. For each of these branches there is an established plan of development for a long period 0, T at constant rates of growth r (T is the same for all the branches). The growth rates r are, as a rule, different for the different branches. In addition, the plan provides for a constant coefficient of scrapping a for each branch: in the interval t, $t + dt$ the volume of production P_t is reduced as a result of the scrapping of old equipment characterized by the highest expenditure of live labour by $aP_t dt$, where P_t is the production of the given branch at the moment t. No changes occur in the existing productive apparatus before modernization other than those due to the scrapping of old equipment. Consequently, the growth of production by $rP_t dt$ is a result of the new production $(r + a)P_t$ arising from investment and the scrapping of old equipment, which reduced productive capacity by $aP_t dt$.

The total volume of production at the new capacity $(r + a)P_t$ may be realized by different investment variants representing different techniques, i.e. by different combinations of investment outlay (expressed in constant prices) and expenditure on live labour (expressed in constant wages). The variants to choose from are, of course, subject to changes as a result of technical progress: new variants displace old ones, which become absolutely ineffective, i.e. variants in which capital investment is higher and labour costs are no lower than in the other variants or vice versa.

Technical progress in the use of materials is left out of consideration. It is assumed that the variants compared over a given period do not differ with regard to expenditure on materials. This corresponds to the premiss that there is a fixed programme for the development of all branches, some of which produce materials for the others. (It will be assumed that the plan is balanced from the point of view of the consumption of materials.)[1]

The amount of capital investment arising from the choice of variant will, as a rule, differ from the production of investment goods adopted in the initial plan. We shall however assume that the necessary changes of proportion between investment and consumption may be made without serious disturbance to the development plans of the individual branches by making full use of the growth of the labour force.

2. Let us denote by i_t the investment intensity of the production $(r + a)P_t dt$, and the labour intensity by c_t. At the time t the separate variants may be represented by different combinations of i_t and c_t. Let us denote the highest labour intensity of the output produced with the existing equipment by x_t, and the growth in labour costs in the entire branch by $\rho_t P_t dt$. We then have

$$(r + a)P_t dtc_t - aP_t dtx_t = \rho_t P_t dt \tag{1}$$

or

$$rP_t c_t dt - aP_t(x_t - c_t)dt = \rho_t P_t dt \tag{1'}$$

The first term in the left side of equation (1′) represents the expenditure on live labour which when taken in conjunction with the corresponding investment will make it possible to increase the production of the branch P_t by $rP_t dt$; the second term represents the saving in expenditure on live labour achieved as a result of the capital investment $aP_t i_t dt$ which replaces the scrapped productive capacity.

The investment per unit of increment of production is

$$i_t(r + a)/r,$$

and the labour costs in the entire branch per unit of this increment are, in accordance with formula (1),

$$\frac{\rho_t}{r} = c_t \frac{r + a}{r} - x_t \frac{a}{r} \tag{1''}$$

[1] This is not completely compatible with the assumption made above that there is uniform growth of the individual branches at rates which are, as a rule, different. The present assumption is made as a first approximation to a materially balanced plan.

It should be noted that as long as scrapping affects only items existing at time 0, the quantity x_t is determined for a given initial state of the branch by the growth rate of production r and by the scrapping coefficient a. Conversely, i_t and c_t are to be selected from the variants existing at time t. However, when equipment installed in the period $0, \ldots, T$ begins to be scrapped, the quantity x_t will not be *fully* determined by r and a, since it is also dependent on the choice of production technique already made in the period 0, T.

Let us denote the sum $\Sigma\,(r + a)P_t i_t dt$ for all branches by $I_t dt$. I_t is therefore the aggregate productive investment of the entire system in the interval $t, t + dt$ in unit time. The sum $\Sigma\,\rho_t P_t dt$ is the additional demand for labour of all branches, which equals the growth in the aggregate expenditure on live labour (expressed in constant wages) in the interval $t, t + dt$. We denote this quantity in unit time by W_t.

3. Let us now consider the problem of the minimization of aggregate investment I_t for a given increase in the labour force at a moment t of the period 0, T. It is assumed in the first stage of the analysis that the quantity x_t is known. In the next stage it is proved that this condition is not essential, given certain further simplifications. It is demonstrated that the volume of investment determined by the method proposed by us will evidently be approximately equal to the minimum at all times t in the period 0, T with the coefficients r and a assigned for all branches and with the given dynamics of the aggregate increment of the labour force.

We start by assuming that the index of the efficiency of investment is a linear function of investment and expenditure on live labour per unit of the increment of production $rP_t dt$

$$E_t = \varepsilon\,.\,i_t \frac{r + a}{r} + \left(c_t \frac{r + a}{r} - x_t \frac{a}{r}\right) \tag{2}$$

where ε is a positive parameter which is the same for all branches. We proceed by choosing for a given ε a variant of i_t, c_t on the basis of the criterion

$$E_t = \min \tag{3}$$

and should E_t be the same for two variants we select the one for which i_t is lower. When x_t, a, and r are given, this criterion is equivalent to

$$\varepsilon i_t + c_t = \min \tag{4}$$

Let us denote the optimal variant by i_t', c_t' and the corresponding index of efficiency by E_t'. We then have

$$E_t' \leqslant E_t \tag{5}$$

Taking the sum over the branches we have

$$\Sigma\, E_t' r P_t\, dt \leqslant \Sigma\, E_t r P_t\, dt$$

and it follows, in accordance with (1″) and (2), that

$$\varepsilon \Sigma\, (r+a) P_t i_t' + E \rho_t' P_t \leqslant \varepsilon \Sigma\, (r+a) P_t i_t + \Sigma\, \rho_t P_t$$

or

$$\varepsilon I_t' + W_t' \leqslant \varepsilon I_t + W_t \tag{6}$$

where I_t' and W_t' correspond to the variants which are optimal for each branch on the basis of the criterion (3) or (4).

4. A change in the parameter ε affects the choice of investment variant. If in some branch there is an E_t' corresponding to ε which is equal to the E_t for another, more investment-intensive variant, an arbitrarily small reduction of ε will lead to the choice of this latter variant. In fact, the indices of the efficiency of investment will then be $E_t' - \Delta\varepsilon i_t'$ and $E_t - \Delta\varepsilon i_t$. The second of these indices is less than the first because

$$E_t' = E_t \quad \text{and} \quad i_t' < i_t.$$

Thus at certain values of ε_k arranged in increasing order, I_t' and W_t' will alter when there is the slightest reduction of ε: whereas $I'_{t,k}$ and $W'_{t,k}$ correspond to ε_k, what corresponds to $E_k - \Delta\varepsilon$ is already $I'_{t,k-1} > I'_{t,k}$ and $W_{t,k-1} < W'_{t,k}$. It follows that $I_{t,k}$ is a decreasing sequence and $W_{t,k}$ an increasing one.

It follows from (6) that

$$(\varepsilon_k - \Delta\varepsilon) I'_{t,k-1} + W'_{t,k-1} \leqslant (\varepsilon_k - \Delta\varepsilon) I'_{t,k} + W'_{t,k}$$

and

$$\varepsilon_k I'_{t,k} + W'_{t,k} \leqslant \varepsilon_k I'_{t,k-1} + W'_{t,k-1}$$

Taking into consideration $I'_{t,k-1} > I'_{t,k}$, we obtain

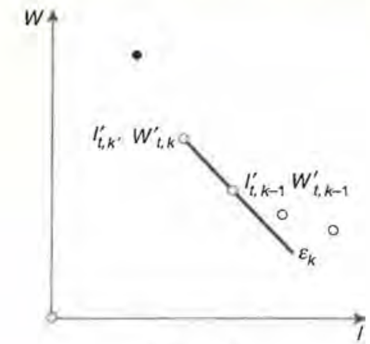

FIG. 40

$$\varepsilon_k - \Delta\varepsilon \leqslant \frac{W'_{t,k} - W'_{t,k-1}}{I'_{t,k-1} - I'_{t,k}} \leqslant \varepsilon_k$$

and, since $\Delta\varepsilon$ is an arbitrarily small quantity,

$$\frac{W'_{t,k} - W'_{t,k-1}}{I'_{t,k-1} - I'_{t,k}} = \varepsilon_k \tag{7}$$

It follows that $I'_{t,k}$, $W'_{t,k}$ may be represented by points forming a descending concave polygonal path. The slope of the segment $I'_{t,k}, W'_{t,k} \to I'_{t,k-1}, W'_{t,k-1}$ is equal (in absolute magnitude) to ε_k (see Fig. 40).

5. The ordinate of a point of the polygonal path defines the demand for the labour force W_t' corresponding to the aggregate capital investment I_t' which is minimum for the given W_t'. It may be assumed that the points of the polygonal path are fairly closely spaced. On the other hand, it may be assumed that the supply of labour (expressed in expenditure on constant wages) will follow demand on a limited scale. We shall therefore not be making a serious mistake if we assume that the supply of 'new' labour S_t equals the ordinate of one of the points F of the polygonal path (see Fig. 41).

It follows from (6) *that the abscissa of this point* $I_{t,F}$ *is the lowest level of investment compatible with the growth of the labour force* S_t *at the growth rate* r, *the coefficient of scrapping* a *and the highest labour intensity of the production of the existing equipment* x_t *assigned for each branch.* We will denote this level of aggregate capital investment by U_t (see Fig. 41).

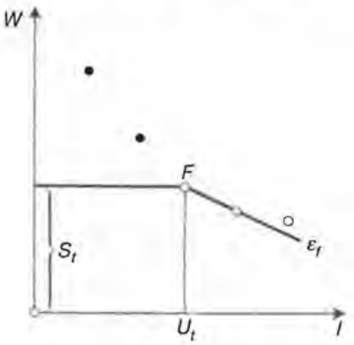

FIG. 41

The slope of the segment of the polygonal path beginning at the point F equals the magnitude of the parameter ε_F. This determines the choice of variants in individual branches. However, if the polygonal path is rigorously determined for the time t, a knowledge of ε_F is not essential for this purpose, since the variants corresponding to ε_F selected in the individual branches, i.e. the branch components of the quantities

$$I_{t,F} = U_t \quad \text{and} \quad W_{t,F} = S_t$$

are directly known. However, if recourse is had to an approximate polygonal path, for example to one previously determined which is shifted downward in conformity with the general rise in labour productivity, x_t is essential for the choice of variants in individual branches.

6. We have therefore concluded the first stage in our analysis in which x_t, the highest unit costs of labour in the operation of the existing fixed capital, are assumed to be given. We shall now demonstrate that, given certain further simplifications, x_t is determined throughout the period 0, T by the initial state of the productive apparatus, by the rates of growth of production in the individual branches and by the branch coefficients of scrapping. Let us now assume that, as a result of technical progress: (i) the c_t' of the variants which are optimal in the period 0, T is lower than the labour intensity of production using any equipment existing at the time 0; (ii) the c_t' of the variants of the period 0, T is a decreasing function of time t. It is additionally assumed that (iii) the expression

$$\frac{1}{r} \cdot \frac{\ln(r+a)}{a}$$

is the same for all branches (this is the most far-reaching of the simplifications adopted).

It follows from (i) that equipment existing at the time 0 will be written off earlier than any items in the period 0, T. It is not difficult to determine the time τ in the course of which this will occur. We have

$$P_t = P_0 e^{rt}$$

Since the production capacity P_0 is completely scrapped in the course of τ we obtain

$$P_0 = \int_0^\tau a P_0 e^{rt}\, dt = P_0 \frac{a}{r}(e^{r\tau} - 1) \tag{8}$$

or

$$\frac{r+a}{a} = e^{r\tau}; \quad \tau = \frac{1}{r} \ln \frac{r+a}{a} \tag{9}$$

It follows from (iii) that τ is the same for all branches.

In the period 0, τ the quantity x_t is defined by the initial state of the basic capital, by the rates of growth of the given branch and by its coefficient of scrapping a. Consequently, during this period the polygonal path at the time t is defined by the coefficients r and a and by the different technical variants known at that time.

The position in the period τ, T is more complicated, since x_t is here also dependent on the choice of variants in the period 0, t. It is proved below on the basis of conditions (ii) and (iii) that the polygonal path at the time t is determined by the initial state of the equipment, by the coefficients r and a, by the dynamics of the growth of the labour force in the period 0, t and by the technical variants at the time t.

It follows from (9) that

$$\frac{P_t}{P_{t-\tau}} = e^{r\tau} = \frac{r+a}{a}$$

or

$$aP_t = (r+a)P_{t-\tau} \tag{10}$$

Consequently, the production capacities scrapped in the interval $t, t+dt$, where $t > \tau$, are equal to the capacities of the equipment introduced in the interval $t-\tau, t-\tau+dt$. But, in accordance with condition (ii), the *actually* selected c_t' which we denote by c_t'', are a decreasing function of t. Consequently, x_t is also a decreasing function of t in the period τ, T. It follows from this and from (10) that the equipment scrapped in the interval $t, t+dt$ is identical to that installed in the interval $t-\tau, t-\tau+dt$ and thus

$$x_t = c''_{t-\tau}; \quad aP_t x_t = (r+a)P_{t-\tau}c''_{t-\tau} \tag{11}$$

Taking (1″) and (10) into consideration, we have

$$S_{t-\tau} = \Sigma\,\rho''_{t-\tau}P_{t-\tau} = \Sigma\,(r+a)P_{t-\tau}c''_{t-\tau}$$
$$-\Sigma\,a\,P_{t-\tau}x_{t-\tau} = \Sigma\,aP_t x_t - \Sigma\,aP_{t-\tau}x_{t-\tau} \tag{12}$$

or

$$\Sigma\,aP_t x_t = S_{t-\tau} + \Sigma\,aP_{t-\tau}x_{t-\tau}$$

from which

$$W_t' = \Sigma\,\rho_t'P_t = \Sigma\,(r+a)P_t c_t' - \Sigma\,aP_t x_t$$
$$= \Sigma\,(r+a)P_t c_t' - (S_{t-\tau} + \Sigma\,aP_{t-\tau}x_{t-\tau})$$

It follows from this formula that, for $\tau \leqslant t < 2\tau$, the polygonal path I_t', W_t' is determined by the coefficients r and a of all the branches, by the choice of variants in accordance with the criterion (4), by the increment of the labour force $S_{t-\tau}$ in the time $t-\tau$ and by the quantities $x_{t-\tau}$ for the individual branches. However, since $0 \leqslant t-\tau < \tau$, these quantities are determined by the initial state of the productive apparatus and by the coefficients r and a. It follows that the polygonal path and also its point U_t, S_t are fully determined at the time t by the coefficients r and a, by the variants existing at this time and by the aggregate flow of the labour force in the past.

It is now readily appreciable that this holds for any time t of the period $0, T$: the polygonal path I_t', W_t' and, consequently, also U_t, S_t will be dependent only on the stipulated factors, which also determine x_t.

It has therefore been proved that when conditions (i), (ii), and (iii) are satisfied the volume of investment determined by the method described in sections 3, 4, and 5 is minimum not only for a given state of the system at the time t, but simultaneously for all the t of the period $0, T$. The conditions from which it follows that the lifetime τ is the same for all branches are not as a rule satisfied (especially (iii)). Nevertheless, the proof of our theorem indicates that the minimum level of investment will probably be reached, even if approximately, throughout the entire plan period $0, T$.

7. Following the analysis of the problem as formulated, we must make some observations on the fixing of the coefficients of scrapping. One alternative is to maintain them at the level existing at the time 0; another is to decide to introduce new branch coefficients a. In the latter case there will as a rule be a displacement of the polygonal path I_0', W_0' at the moment 0 and a corresponding alteration in the minimum of aggregate investment U_t.

Even if the 'new level is not below the former level, this should not be taken as indicating that the 'reform' is necessarily desirable because an alteration of a may lead to the converse situation for some $t > 0$. In fact, this alteration affects the dynamics of the highest labour intensities of production with the old equipment. Corresponding to each set of branch coefficients of scrapping there is an approximately optimal time curve of investment in the period $0, T$ arrived at by the methods outlined above. But in general these curves intersect, so that there need not necessarily be a curve lying lower than the others for all the t of the period $0, T$. A decision of the central planning organs is therefore needed whenever a discrepancy arises between the volume of capital investment and, consequently, of consumption in the short term and in the long term.

Another question arises in connection with coefficients of scrapping. It follows from section 3 that the choice of investment variants at the time t is based on criterion (4), in which ε is determined (in accordance with sections 4 and 5) by the polygonal path I_t', W_t' and by the increment of the labour force at the moment t. It is clear that the 'durability' of equipment is not a factor which has any influence on such a process of the choice of investment variants. It should, however, be borne in mind that 'durability' is a problem which is closely connected with 'obsolescence' resulting from technical progress and that it is therefore an economic rather than a technical factor, to be decided by the central planning organs. If our approach to this problem is to adopt a fixed coefficient of scrapping for the given branch, a constant proportion of the production capacity characterized by the highest labour intensity is annually scrapped irrespective of whether or not it corresponds to the accepted definition of 'durability'.

To avoid misunderstanding, it should also be noted that expenditure on repairs, on spare parts, and on other items which depreciate fairly rapidly is not regarded as capital investment connected with the scrapping of old equipment, but as running costs by analogy with expenditure on materials.

8. So far we have assumed that the only changes in the existing basic capital are in the scrapping of obsolete equipment in service. We shall now give general consideration to the problem of modernization in the sense of a reduction of labour costs in the various elements of a functioning productive apparatus as a result of investment which to some extent modifies this apparatus.

As has been noted in section 2 in the analysis of formula (1′), the object of replacement investment $aP_t i_t dt$ is to effect economies in live labour $aP_t(x_t - c_t)dt$. The ratio of these economies to the investment needed to effect them is $(x_t - c_t)/i_t$.

Let us assume that there is some scope for modernization of the productive apparatus of a given branch for which the ratio between the savings in live labour and the investment by means of which it is effected is greater than $(x_t - c_t)/i_t$. (It should be noted that $(x_t - c_t)/i_t$ is dependent on the variant i_t, c_t of new investment.)

In such a case it will be correct to substitute investment on modernization for all or a part of the 'replacement' investment (the amount of investment undertaken to reduce costs on live labour, and also the overall investment are unaffected). In fact, we shall then directly economize more on live labour than in the case of the scrapping and replacement of equipment with the highest unit expenditures on live labour x_t. In addition, we improve the scope for economy of live labour by the scrapping of obsolete equipment in the future.

In the given state of the fixed capital in service the scope for modernization is higher for those variants for which $(x_t - c_t)/i_t$ is lower. Consequently, in the given variant in which modernization

is taken into account an increase in expenditure on live labour is no longer

$$\rho_t = rc_t - a(x_t - c_t) \tag{1′}$$

but is

$$\rho_t = rc_t - a f_t\left(\frac{x_t - c_t}{i_t}\right) \tag{13}$$

where f_t is a decreasing function and

$$f_t[(x_t - c_t)/i_t] \geqslant x_t - c_t$$

(the equality is omitted when there is no scope for appropriate modernization).

By analogy with (2) we shall now apply the term 'index of efficiency' to

$$E_t = \varepsilon i_t \frac{r + a}{r} + c_t - \frac{a}{r} f_t\left(\frac{x_t - c_t}{i_t}\right) \tag{14}$$

With an assigned ε the variant i_t/c_t is selected in accordance with the criterion $E_t = \min$, and if E_t is the same for two variants we once again select the least investment-intensive. The choice, in contrast to the deduction in section 3, will here be dependent on the value of $f_t[(x_t - c_t)/i_t]$, which will differ for the different variants. Summing over the branches, we have

$$\Sigma E_t' r P_t dt \leqslant \Sigma E_t r P_t dt$$

where E_t' is an optimum variant. From this, reasoning in the same way as in section 3, we obtain

$$\varepsilon I_t' + W_t' \leqslant \varepsilon I_t + W_t$$

where

$$I_0' - \Sigma i_t'(r + a)P_t$$

as in section 3, but

$$W_t' = \Sigma rc_t' P_t - \Sigma a f_t\left(\frac{x_t - c_t'}{i_t'}\right)$$

We may now draw the polygonal path I_t', W_t' in the time t, which when taken in conjunction with the increase in labour force in this time S_t defines the minimum investment U_t. The level of investment will be less than or the same as when an economy of manpower is achieved solely by means of replacement investment.[2]

2. Assessment of Different Variants of the Expenditure on Materials and of the Role of Foreign Trade

1. So far we have assumed that the variants of investment in a given branch differ only in investment intensity i (in constant prices) and labour intensity c (in constant wages). When we come to consider the features of the different variants in relation to expenditure on materials, we have to calculate expenditure on materials in the investment variants which we compare and also in the items scrapped.

The complete capital investment and expenditure on live labour involved cannot be included in equations corresponding to (1) and (2), since they would then be taken into consideration twice or more times in the summing of these equations, because some of the branches produce materials for others. More detailed information concerning the plan is needed over a lengthy period 0, T if this question is to be appropriately solved.

Since the plan is balanced from the point of view of expenditure of raw materials, certain rates of their expenditure in individual branches in the time t are accepted in it. When we select one of the investment variants we should give consideration to the positive or negative *deviations* from these rates. (As we shall see, the same problem will arise in relation to expenditure on materials in items to be scrapped, where the total expenditure on live labour and materials per unit of production are highest. The expenditure of materials on these items may differ from the expenditures adopted in the plan, in which case it is once again necessary to take the *deviation* from the plan into consideration.)

We should now apparently proceed as follows. In addition to the capital investment and expenditure on live labour of the stage of production represented by the given branch, we must also consider the 'accompanying' capital investment and expenditure

[2] A question which may arise is how to determine the coefficient of scrapping a for a given branch when there is modernization. This coefficient may readily be found by comparing the production with the new equipment $(r + a)P_t\,dt$ and the increase in the production of the branch $rP_t\,dt$, i.e. in the same way as in the complete replacement of obsolete equipment.

on live labour, corresponding to the expenditure of materials, but only on the scale of the deviation of this expenditure from the rates adopted in the plan. (For a variant in which the expenditure on intermediate and raw materials coincides with the amounts adopted in the plan we therefore have to consider only the capital investment and expenditure on live labour of the given phase.)

Such an approach would be correct only in the case of a closed economy. If we consider foreign trade, we shall arrive at different conclusions. A distinction may be drawn between 'currency' materials, i.e. those sold in foreign trade, and 'non-currency' materials, i.e. those not sold in this trade owing to high transportation costs (e.g. bricks) or because of other difficulties of sale, e.g. electric power and machine parts. In relation to 'non-currency' materials it is appropriate to use the method referred to above of allowing for the corresponding 'accompanying' capital investment and expenditure on live labour on the scale of deviations from the rates adopted in the plan. Such an approach is not as a rule satisfactory where 'currency' materials are concerned.

In fact, the plan for development of the economy includes a more or less definite plan of foreign trade, i.e. we know the structure of exports and of the production aimed at reduction of imports. On the basis of this information we find a group of commodities for export or for 'import substitution', for which the following condition is satisfied: if the currency cost of the 'currency' materials consumed is subtracted from the currency value of its production, and if the capital investment and labour for one currency rouble of this net currency value are denoted by j and k respectively, the criterion for this commodity group for a given ε is expressed in the form $\varepsilon j + k = \min$.

Further, if one investment variant is more economic than another with respect to expenditure on 'currency' materials by d currency roubles, the currency economized may be used to reduce the growth in the export or to increase the growth in the import of the commodity group referred to above and thereby to secure the maximum economy of 'calculated expenditure' for the given ε, namely on the scale $d(\varepsilon j + k)$. (It should be noted that j and k should be selected from the technical point of view in relation to the criterion (4).)

2. It is now possible to compile formulae similar to (2) and (4) which allow for the scope of the different variants of the consumption of materials and for technical progress in this sphere. In the interests of simplicity we shall at present leave out of consideration expenditure of 'non-currency' materials (and also modernization).

Let us denote the currency value of the deviation of direct expenditure of materials from the quota in the time t by δ_t. In that case the 'calculated expenditure' on a unit of output will be

$$\varepsilon i_t + c_t + \delta_t(\varepsilon j_t + k_t)$$

The equipment which should be scrapped for a given ε is that for which the expression

$$x_t + \lambda_t(\varepsilon j_t + k_t)$$

reaches a maximum, where x_t is the labour intensity of production for the scrapped equipment, and λ_t is the currency value of the deviation from the quota for the expenditure on materials for this output as adopted in the plan.

Consequently, (2) will correspond to

$$E_t = [\varepsilon i_t + c_t + \delta_t(\varepsilon j_t + k_t)]\,\frac{r+a}{r} - [x_t + \lambda_t(\varepsilon j_t + k_t)]\,\frac{a}{r} \tag{15}$$

or

$$E_t = \varepsilon\left[i_t\,\frac{r+a}{r} + j_t\left(\delta_t\,\frac{r+a}{r} - \lambda_t\,\frac{a}{r}\right)\right] - \left[(c_t + \delta_t k_t)\,\frac{r+a}{r} - (x_t + \lambda_t k_t)\,\frac{a}{r}\right] \tag{15'}$$

where j_t and k_t are the same for all branches. As in the first part, the branch variants will be selected by the criterion $E_t = \min$, and once again should E_t be the same for two or more variants, the least capital-intensive is selected (the variant for which the first expression in the square brackets in formula (15′) is least). Since r, a, f_t, and k_t are the same for all variants of a given branch, and since this also holds with respect to λ_t for the given ε, we may write the criterion of the choice of variants at the time t in the form $\varepsilon(i_t + \delta_t j_t) + (c_t + \delta_t k_t) = \min$.

If we denote the rate adopted in the plan for the currency value of materials expended per unit of output by n_t

$$n_t + \delta_t = \sigma_t$$

will be the currency value of the total specific expenditure of materials in the given variant. Since n_t is the same for all variants, the criterion may be written for a given ε as

$$\varepsilon(i_t + \sigma_t j_t) + (c_t + \sigma_t k_t) = \min \tag{16}$$

When two variants are equal, the one chosen is the one for which $i_t + \sigma_t j_t$ is less.

If we denote the optimum variants by i_t', c_t', and δ_t' and the corresponding indices of efficiency by E_t', we have $E_t' \leqslant E_t$.

Taking all branches together we obtain

$$\Sigma\, E_t' r P_t\,\delta_t \leqslant E r P_t\,\delta_t$$

and, by analogy with section 3 of the first part,

$$\varepsilon I_t' + W_t' \leqslant \varepsilon I_t + W_t,$$

where the capital investment and expenditure on live labour also allow for investment and expenditure which are a result of deviations in the consumption of raw materials from the rates adopted in the plan. I_t' and W_t' correspond to variants selected for a given ε by the criterion (16).

There is therefore a polygonal path I_t', W_t' for the time t with the same properties as the polygonal path in Fig. 40. Taken in conjunction with the growth in manpower it determines the lowest level of capital investment U_t compatible with this growth. The most effective variants of individual branches are simultaneously determined.

3. Expenditure on 'non-currency' materials was left out of consideration in the last section in the interests of simplicity. We have previously noted that it is appropriate in relation to such materials to use the method of calculating the accompanying capital investment and expenditure on live labour in a given variant on a scale corresponding to the deviation between the expenditure on materials and the standards adopted in the initial plan. The highest expenditure on live labour and raw materials in an existing productive apparatus are determined as follows. When calculating expenditure on live labour and materials for a given ε, we consider, in addition to 'currency' materials, the capital investment and live labour corresponding to deviation from the plan of

expenditure on 'non-currency' materials in the existing equipment. After this we determine which items of the total capacity aP_t should be scrapped in unit time on the basis of the total expenditure on live labour and materials in the given stage of production thus calculated.

However, we shall not complicate (15) and (16′) by the inclusion of elements associated with different variants of the consumption of 'non-currency' materials, but shall assume that the investment associated with 'non-currency' materials in the variant under consideration or in the scrapped equipment is allowed for in i_t, and that the corresponding expenditure on live labour is allowed for in c_t. Hence the points of the polygonal path I_t', W_t' show expenditure with allowance for expenditure on 'non-currency' materials on the scale of the deviation from the plan.

It may be assumed for the formula corresponding to the criterion (16) that i_t and c_t incorporate the *total* investment and expenditure on live labour connected with the expenditure of 'non-currency' raw materials. In order to avoid confusion between the values of i_t and c_t in the criterion as expressed in (16) and (15), we may replace these symbols in (16) in the new interpretation by r_t^* and c_t^*, and the expression then becomes

$$\varepsilon(i_t^* + \sigma_t j_t) + (c_t^* + \sigma_t k_t) = \min \qquad (17)$$

4. In section 6 of Part 1, where we left variants of the consumption of materials out of consideration in the problem, it was demonstrated that, given certain fairly considerable simplifications, the plan for the development of the economy (including coefficients of scrapping), taken in conjunction with the initial state of the basic capital and the dynamics of increase in manpower, fully defines the polygonal path I_t', W_t' for the time t. We thus also determine the choice of variants at each moment of the period 0, T which minimizes capital investment I_t throughout this entire period. Because the conditions on which the proof of this theorem is based are not in general satisfied, it merely indicates the probability of the hypothesis to which it approximates.

In order to be able to prove this theorem, one further simplification must be introduced when calculating the different variants of the consumption of materials, namely that the highest labour intensity of production in the given branch x_t is characteristic of the items scrapped. (It follows from the two previous sections that this condition is not as a rule satisfied.) This simplification is, however, far less risky than the three 'special' premisses of the proof of the theorem in section 6 of Part 1 in connection with the relatively small contribution of economy of materials to technical progress. To take progressive saving of raw materials into consideration does not therefore significantly reduce the probability that our theorem will be approximately suitable for practical purposes.

5. Now let us consider a completely different matter, namely the problem of an alteration of the originally planned branch structure of new production at a moment t as a result of optimum choice of variants in the manner described above. We have already demonstrated that minimization of investment may cause such changes in branch structure: the savings in investment outlay are used to increase consumption to such a degree that the growth in manpower is fully utilized.

This problem is even further complicated when variants of the consumption of materials are taken into consideration, since this causes simultaneous modification of the structure of the growth in foreign trade (in production both for export and for import-substitution).

In relation to foreign trade, the structure of the new production for export or for import-substitution has to be 'verified' on the basis of the parameter ε_t derived above. In fact, the choice of technological variants for a given commodity group does not differ fundamentally from the choice between production for export or for import-substitution of different commodity groups as a result of which one currency rouble is obtained. The value of $\varepsilon_t i_t^*$ must therefore be compared for different commodity groups at the time t. Here i_t^* is the investment needed for the production in the given commodity group of the net currency worth of one currency rouble, i.e. after subtraction of the value of 'currency' materials. (Investment which serves for the production of 'currency' raw materials is consequently not taken into consideration in this capital investment.) The related expenditure on live labour for one currency rouble is denoted by c_t^*.

Comparison of the expressions $\varepsilon_t i_t^* - c_t^*$ for different variants of production for export or for import-substitution with the new equipment does not lead to the choice of one or more commodity groups. The point is that the 'best' export variant has in general only fairly limited potential application in connection with the limited capacity of foreign markets. Nevertheless, comparison of these values will enable us to make some obvious corrections to the plan for the growth of foreign trade. This emerges as one further factor in the alteration of the structure of production.

The 'correct' level of investment, the 'new' consumption of raw materials, and the 'new' structure of foreign trade for the time t are determined on the basis of the results of all these calculations. The greatest difficulties in plan reconstruction may arise from the 'correct' level of investment.

We have already mentioned that, for example, economy in investment may be used to increase consumption to such an extent that manpower continues to be fully used. In general, however, different branches produce investment and consumer goods. Let us assume that the 'correct' investment at the time 0, i.e. U_0, is considerably less than the production of finished investment goods for the internal market at the same time. This creates a difficult situation because an immediate shift in branch structure from investment to consumption is impossible.

The most rational approach will evidently be the following: the 'surplus' production of the capital goods producing branches must be exported in exchange for consumer goods (over and above the 'normal' foreign trade). Although this exchange may possibly not be very advantageous, consumption will at all events increase. There will be a simultaneous rapid expansion in the production potential of consumer goods and no expansion in the potential for investment goods. The production of these goods will therefore correspond to U_t' within a comparatively short period t', and their 'excessive' export will cease to be necessary.

For $t > t'$ the difference between U_t and the production of investment goods is already of the order of dt and may be overcome in a short time.

The same applies to consumption of raw materials and to the structure of foreign trade for the whole period 0, T since the reference is here invariably to variants in the interval t, $t + dt$ (for example, to expenditure of coal or oil in *new* factories).

We thus arrive at a plan with new branch growth rates for the time t and therefore, by applying the foregoing methods to it, we in general arrive at a different polygonal path for this time. If it

differs little from that originally established, we may regard our task of the choice of (technical and foreign trade) variants as completed. If not the process of gradual approximation will be continued.

This process will probably be convergent and even rapidly so, but there can be no absolute certainty of this. A warning should here be given against convergence arising from the lack in many instances of fundamentally differing technical variants (this is a basic problem relating to the practical use of the theory of investment efficiency, which is a theory which cannot in itself *give rise* to new investment variants).

It should also be noted that in following the method described above we infringe the initial assumption that individual branches develop uniformly, although at different rates. It may readily be appreciated that this will not essentially modify the construction of the polygonal path I_t', W_t' at the time t; at the same time the achievement of a minimum of investment throughout the entire period 0, T becomes even more approximate.

6. We excluded modernization from consideration above. Let us return to (15) and introduce the notations

$$\left.\begin{aligned} h_t &= i_t + \delta_t j_t \\ b_t &= c_t + \delta_t k_t \\ v_t &= x_t + \lambda_t(\varepsilon j_t + k_t) \end{aligned}\right\} \tag{18}$$

We may now rewrite (15) as

$$E_t = \varepsilon h_t \frac{r + a}{r} + b_t - \frac{a}{r}(b_t - v_t)$$

If we then argue as in section 8 of the first part, taking the possibility of modernization into consideration, we obtain

$$E_t = \varepsilon h_t \frac{r + a}{r} + b_t - \frac{a}{r} f_t\left(\frac{v_t - b_t}{h_t}\right)$$

where f_t is a decreasing function and

$$f_t\,[(v_t - b_t)/h_t] \geqslant v_t - b_t$$

For the given ε we select a variant by the criterion $E_t = \min$. It is now possible to construct the polygonal path I_t', W_t' and to obtain for a given growth in manpower a value of U_t and branch variants which minimize aggregate investment at the time t.

The Scope of the Evaluation of the Efficiency of Investment in a Socialist Economy[1]

(1970)

1. The efficiency of investment is evaluated in principle in the socialist centrally planned economies for two purposes: (i) the comparison of different technological variants for the achievement of the same productive target; and (ii) the comparison of different possibilities of obtaining the amounts of foreign currencies necessary to cover import requirements, either by means of exports or by means of national production aimed at import substitution.

It is often said, not only in the West but also in the socialist countries, that such application of the calculus of effectiveness has too limited a character, because it leaves, it seems, the general directions of development of the economy to the arbitrary decisions of the planning authorities. We shall try to show here that such contentions are based on a misunderstanding. (It is true that the evaluation of investment efficiency could still be enlarged to include the determination of the consumption structure, but this is a problem much more complex than the two mentioned above, since it requires the definition of equivalence of two consumption aggregates of different structure; see section 3 below.)

2. Let us begin by considering a fictional, but none the less instructive situation. Let us imagine a closed economy in which there are no technological alternatives, i.e. each productive target can be achieved in one way only. Let us assume further that in the perspective plan the planning authorities have determined the growth path of national income through time (measured at constant prices) and also the structure of consumption and unproductive investment, as well as the relation among these magnitudes in each year of the plan.

It can easily be seen that in such conditions there exists only one balanced-plan variant. The volume and structure of investment are determined by the planned growth of national income, and so are the structure of consumption and unproductive investment, and the relation between these two magnitudes. Suppose, for instance, that consumption is at a level higher than in the plan so constructed. Then, since the relation between consumption and unproductive investment is given, the structure and volume of investment also have to be adjusted, and for a given national income less is left for productive accumulation and the increase in circulating capital. The lower level of these magnitudes, in turn, without the possibility of technical choice and the operation of international trade, and also for a determined structure of consumption and unproductive investment, cannot in any way be sufficient to achieve the increase of national income assumed in the plan.

Not only cannot the volume of investment undergo change with respect to the plan constructed, but neither can its structure, because again the assumptions made would not allow the achievement of the assumed structure of consumption and unproductive investment. This means that in a situation where there is no problem of choice of production techniques nor of foreign-trade variants, once the planning authorities have determined the time-path of national income, the structure of consumption and unproductive investment, the problem of evaluation of investment efficiency does not arise.

Together with the possibility of choice of techniques and of various patterns of foreign trade, two degrees of freedom arise, and indeed it is within the framework of these degrees that the evaluation of investment efficiency can operate—given the assumptions made by the planning authorities about the growth rate of national income, the structure of consumption and unproductive investment.

3. In practice we are faced exactly with such a situation. The plan should really be constructed for several hypothetical paths of national income growth, and the planning authorities should choose among them; and given the conflict between consumption in the short and the long run that usually arises, this choice contains elements of political character. By constructing each of the plans corresponding to hypotheses in the field of growth paths, a given structure of consumption and unproductive investment is assumed more or less in a discretionary way: either the consumption at the end of the plan is patterned on the more developed countries and interpolations are made for the intermediate years; or the income elasticities of demand for different commodities, taken from family budgets, are used as guide-lines; or, finally, both methods are used at the same time in order to formulate a view about this problem, and then take the final decision about it.

As we have already said (in section 1 above) the calculus of investment effectiveness could be extended to include the problem of choice of the 'cheapest' consumption structure. Then we must introduce the criterion of equivalence of two different consumption aggregates. A first step in this direction is contained in my paper 'The Problem of the Optimum Structure of Consumption',[1] where I have also outlined a method for the choice of consumption structure in the perspective plan. My preliminary ideas, however, have not yet reached either a general solution, or a practical application. Therefore we still take the decision about the structure of consumption (and unproductive investment) as given in the plan variants corresponding to different growth rates.

4. In such conditions, the field in which we assess the efficiency of investment is, as we have said above, the choice of techniques for the achievement of given productive targets and the pattern of exports and imports. The task of the evaluation of efficiency understood in this way is the achievement of the minimum investment consistent with the maintenance of equilibrium in the balance of the labour force and the balance of payments. In other words, for a given value of exports that covers (together with possible foreign loans) the value of imports, investment should be fixed at the lowest level at which the full employment of the labour force is obtained. A lower level of investment would mean that the plan is unrealistic, given the unemployment of labour. A higher level of investment would in turn imply a waste of resources that would negatively affect consumption.

From this argument, on the other hand, one should not draw the conclusion that the investment calculus can by itself determine completely the pattern of foreign trade or even the productive techniques. An obstacle to obtaining the most effective export pattern can appear due, from the supply side, to technical–organizational factors limiting the growth rate of particular branches,

[1] [See this volume.]

and from the side of demand, to the insufficient absorption capacity of foreign markets. The export pattern is most effective when the rate of its expansion is low. Also, even the application of some effective technology can meet long-term bottlenecks. For instance, the burning of oil is more effective than the burning of coal, but in Poland that depends on the import of crude oil, and therefore it raises the foreign trade difficulties mentioned above.

If we take into account this set of problems, then it appears that the necessary investment is in principle higher than the level which we would obtain by applying the 'pure' evaluation of investment efficiency.

5. It is also worth further illustrating the arguments above, by using them to answer the frequent question whether manufacturing industries should not be developed, because of their lower capital intensity, rather than primary industries producing raw materials. If we treat the question independently of foreign-trade considerations, it really makes no sense at all. We cannot produce machines rather than copper, since that leads to a surplus of machines and a deficit of copper.

Only if this problem is considered within the context of foreign trade can an answer to it be found in the calculus of investment efficiency. This calculus can in fact show that it is more advantageous to produce machines for export and to import copper in exchange, rather than produce copper at home. But even this, in the light of the considerations of section 4 above, still does not prejudge the issue. The point is that it is not necessarily feasible for the export of machines to be expanded in order to import copper, and we might have to sell the machines so cheaply that this becomes ineffective. Therefore the construction of a copper-mine, regardless of its capital intensity, can turn out to be, in the end, an appropriate way of implementing the development plan of the economy.

Generally speaking, the so-called problem of the 'directions of development' makes sense only when it is treated as the choice of the pattern of foreign trade (as well as the production technology), because only then does it not lead to plan imbalance. Once the problem is formulated in this way, it *can* be solved by means of the calculus of investment efficiency, provided allowance is made for the absorption capacity of foreign markets for different export goods, and for the technical–organizational barriers to the development of the production of particular branches.

PART 3

SOME ECONOMIC AND SOCIAL PROBLEMS OF PEOPLE'S POLAND

Observations on Labour Productivity[1]
(1960)

In the current discussion on the subject of raising the productivity of labour, the latter is often treated as a panacea for accelerating economic development and increasing prosperity. In a sense, this brings to mind the debates of a few years ago, in which the use of a system of incentives in economic management was regarded as such a panacea. I took part in that discussion, warning that the matter is not as straightforward as it might at first glance appear.[1] My observations now are in a similar vein. Undoubtedly the growth of labour productivity is one of the determining factors in economic development. However, the stress that is laid on increasing it in particular branches of production should depend on the nature of that increase on the one hand, and on conditions in the economy as a whole on the other.

1. In considering the effects of an increase in labour productivity, it is necessary first of all to distinguish two sets of circumstances:

(i) An increase in labour productivity leading to higher production with a constant level of employment.
(ii) An increase in labour productivity leading to a decrease in employment at a constant level of production.

If, for example, in some factory the speed of operation of certain machines is increased, then with a given labour force there will follow an increase in production resulting from a more intensive use of the productive equipment and the labour force. If, however, the increase in productivity is the result of the same machines, operating at the same speed, and being worked by a smaller number of workers, then the same level of production corresponds to a decrease in employment.

The first case implies a direct increase in national output. The second case merely indicates the saving of labour power, which may be more or less advantageous for the economy, depending on the situation in the labour market.

[1] See my article, 'Workers' Councils and Central Planning', [*Collected Works*, vol. iii].

2. After making this distinction, it should be noted that the more useful kind of increase in a factory's production, through a better use of its given productive equipment and workforce, may also, in practice, present various complications.

First of all, a necessary condition for such a favourable solution is additional supplies of raw materials. In view of this, it would be necessary to increase production of the appropriate raw materials, and/or expand exports in order to allow for reduced exports of those raw materials, or the increase in imports of them, otherwise the balance of payments would be disturbed. It should be pointed out that such a successful co-ordination of production (and exports, when it comes to bridging the gap through foreign trade) may not always be possible, and in any case will not occur automatically in the course of achieving the general aim of increasing labour productivity.

If, as a result of a lack of additional raw materials supplies, the goal of increasing production is abandoned, and labour productivity is nevertheless forced up, then the first case turns into the second one, i.e. instead of increasing production, a decrease in employment will result. If, for example, the increase in productivity is the result of a faster rate of operation by machines, but materials supply problems render an increase in output impossible, then employment will be reduced to some extent. At the same time, part of the productive apparatus will stand idle, when previously it was active. This will be offset by the faster operations of the machines when active, with the result that the overall degree of capacity utilization will stay the same.

3. Problems with expanding production may arise not only on the side of input supplies, but also on the marketing side. Thus, for example, an increase in the production of consumer goods for which there is no market demand leads only to a build-up of stocks. An increase in production in these circumstances would therefore bring no benefit to the economy. On the contrary, it would tie up raw materials and render ineffective the foreign currency spent on achieving it.

Arguing in a systematic manner, it is obviously possible to say that this danger will not arise, since an increase in the commodities available allows for a corresponding increase in real incomes, through an increase in wages or a decrease in prices. But

even then, the matter is far from simple. With higher real incomes, there is an increase in demand not only for those consumer goods whose supply happens to be increasing as a result of higher productivity, but also for those, e.g. foodstuffs, whose supply has not increased. This makes increasing incomes more difficult, since in these conditions it leads to disequilibrium in certain markets.

In theory it is possible to get round this by changing relative prices, namely by lowering the prices of the surplus commodities sufficiently in relation to the prices of other consumer goods. To secure equilibrium in all markets, however, it may not be enough merely to lower the prices of the surplus commodities. This is because, as we have already mentioned, the resulting increase in real incomes may cause an increase in demand for other products as well. In this case, a simultaneous increase in the prices of those other commodities is necessary. The increase in real incomes would then arise as a result of the difference between the effect of the reduction in the prices of other consumer goods. If, however, the price increase affects necessities, then this manœuvre would encounter practical difficulties, since the population may view unfavourably an increase in real incomes achieved in this way. Besides, at low levels, real incomes may actually fall as a result of such a price reform.

If, as a consequence of the above-mentioned difficulties, real incomes are not increased to a level appropriate to the higher production of those consumer goods benefiting from the increased productivity, then obviously there will be an increase in stocks as stated above.

4. It is clear that an increase in productivity leading to a better utilization of productive capacity will contribute to raising production in the whole economy. However, if the additional demand or market does not exist, then difficulties arise for the balance of foreign trade, or in the stockpiling of unsold commodities. But avoiding these undesirable effects leads to the abandonment of increasing production, and therefore to the use of the increase in productivity solely to lower the required level of employment. Let us now examine the circumstances in which this 'saving of labour' brings substantial benefits.

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It is clear that if a country suffers from a general shortage of labour, i.e. if the labour force and not the productive apparatus is the bottleneck holding up production, then the raising of labour productivity is indispensable for the full utilization of that productive capacity. If, however, there is no general labour shortage, then additional labour-saving allows working hours to be reduced. If this is not done, then labour-saving leads to a reduction in the migration of labour from the rural economy, reduced employment of married women and young workers, and ultimately to unemployment in one form or another. In this case, the increase in labour productivity within factories does not raise the social productivity of labour, since it is offset by the lower level of employment.

This reasoning does not, however, conclude the subject. Although the labour force *as a whole* may be altogether sufficient to man the productive apparatus, *in certain sectors* shortages may occur. Labour shortages may arise in particular branches of production, e.g. in mining, among particular age and sex groups, e.g. there may be a deficit of adult men, and finally in certain regions. In these cases, the application of labour-saving arrangements, appropriate to the particular labour shortage, takes on a fundamental importance, although this does not necessarily warrant the implementation of such a policy on the scale of the economy as a whole.

5. Hitherto we have implicitly assumed that we are dealing with a given productive apparatus, and we have therefore considered the consequences of raising labour productivity in that given economic situation. Let us now imagine that we are drawing up some long-term national economic plan, and that we are considering the influence that an acceleration in labour productivity will have on our development of this plan. An argument conducted along the lines of the one above will here give different results.

In this case, an increase in labour productivity of the kind that leads to improved utilization of productive equipment (whether existing or new), takes on a different aspect. Essentially, the greater production obtained from a given plant allows the investment required to realize a given programme of production to be reduced, and this saving in investment in its turn allows either a reduced level of investment and a correspondingly higher level of consumption, or the achievement of a greater increase in national output with a given level of investment. In both cases, the prob-

lems of supplies and markets, which were mentioned in sections 2 and 3, will be diminished, if not altogether eliminated, since the necessary changes in the structure of production may be obtained to a great extent by the appropriate changes in the structure of investment.

In this context, the modernization of old factories acquires a special significance. Such modernization enables their productive equipment and workforces to be better employed, at the cost of relatively small investment outlay.

As for making arrangements for 'pure' labour-saving in a long-term plan, i.e. reducing the level of employment corresponding to a given production plan, the matter may be represented in a similar way to the results of our considerations relating to a current economic situation, that is, under the assumption that the productive capacity is given. The long-term plan anticipates a particular increase in productive capacity which, combined with assumptions about the technology to be used, defines the requirements for labour. To induce labour-savings to a greater degree than is required to obtain such a demand for labour as will be necessary to employ the forecast supply of labour may only be done in order to carry out a reasonable programme of reducing working hours. Moreover, such an induction of labour-savings often requires considerable additional investment outlay.

Obviously we are also concerned here with the demand for labour not only in the whole economy, but in particular sectors too. In view of this, efforts to raise productivity must be set out in the plan differently according to the respective branches of industry, sex and age groups, and regions.

6. Summing up, two cases of increasing labour productivity need to be distinguished: (i) when it is linked to better use of productive equipment, and (ii) when it constitutes 'pure' labour-saving.

With a given productive capacity in the first case, it is possible to increase production holding the level of employment constant. However, this may precipitate problems with the balance of foreign trade, or the stockpiling of unsold goods. If increasing production is renounced, then case (i) becomes case (ii) 'Pure' labour-saving in a situation where there is no shortage of labour leads only to a reduced rate of employment, which does not raise the *social* productivity of labour.

In the phase of *planning*, when we are dealing with an expansion of the productive apparatus, case (i) is undoubtedly beneficial, in that the greater production obtained from given productive equipment allows the construction of new capacity to be diminished. At the cost of this saving in investment, consumption may be increased, or a greater increase in national output may be obtained with the same level of investment. In case (ii) the acceleration of labour productivity is useful only to prevent a shortage of labour in the economy as a whole, or in some specific sector, or to carry out a reasonable programme for reducing working hours. But it should be borne in mind that such induced labour-savings may themselves often require considerable additional outlay on investment.

It follows from this that labour-productivity policy ought to have a distinctly differentiated and composite character, taking into account the nature of the increase in such productivity and its repercussions on the size and structure of national output and the situation in the labour market.

In conclusion it should be added that raising the productivity of labour is often approached from the point of view of reducing costs and increasing financial accumulation. In a socialist economy, these issues can be settled by applying appropriate pay, price, and fiscal policies. Policy on labour productivity ought to be subordinated to the carrying out of production goals and balancing the demand and supply of labour, while allowing for a programme of reductions in working hours.

A Contribution to the Discussion on the Perspectives for Development of Agriculture[1]
(1961, 1963)

I would like to make a comment on a subject which has already been discussed by others. I fully agree with the opinion that one should not underestimate the state putting-out system in agriculture as an element of developing socialism in the countryside. We argue that the American farmer is no longer an independent entrepreneur but a homeworker within the system of monopoly capitalism. The same would be true of a fully developed state putting-out system in which the peasant would not be a private entrepreneur, but a homeworker within the system of the socialist economy.

Of course, it would then be hard to speak of a fully socialist agriculture since the income of farmers would still depend on the size of their farms. However, it must be noticed that we are still far from the implementation of even such a putting-out system. True, the system of state purchasing contracts accounts for a very large part of sales of agricultural goods. But the agricultural associations, whose assistance is indispensable for rapid development of peasant farming, are for the time being mainly concerned with the mechanization of agriculture. Their activity does not yet extend to the introduction of technical progress through better use of fertilizers and fodder, the promotion of more suitable crops, improved livestock, etc. It must also be noticed that socialism is not fully implemented outside agriculture as well. Artisan co-operatives and producer co-operatives are often disguised semi-private enterprises. The elimination of private ownership in agriculture must therefore be considered from the perspective of implementing full socialism in the whole economy.

As regards transition from private farming to agricultural co-operatives, the debate failed to consider one very essential problem—whether members of producer co-operatives are to retain their private gardening plots. As experience teaches us, these plots are doubtless an element which internally breaks up the co-operative, since, to the disadvantage of jointly cultivated land, they become the object of much work-effort by the co-operative's members. Introduction of 'pure' producer co-operatives runs in turn into very serious difficulties. Therefore, I agree with those speakers who stressed the importance of one-man leadership in large socialist farm-estates, for instance some forms of State Agricultural Farms. It seems that the successful functioning of the agricultural co-operative largely depends on close links between its members, and that the future of the socialist economy in the countryside belongs equally to various forms of State Agricultural Farms and to typical co-operatives.[1] Therefore, I consider the improvement in functioning of the State Agricultural Farms, which was discussed here at some length, as a very important matter.

In light of the above, I see the following parallel paths of stimulating the development of economic activity in the villages:

1. There is a gradual strengthening of the putting-out system which is based on purchasing contracts and agricultural associations. The latter should provide assistance to small farms and therefore cease to focus on mechanization, which plays a crucial role only after small-scale commodity production is transformed and becomes large-scale production. The agricultural association should, above all, provide farmers with the services which they need to develop their output and which they cannot provide themselves.

2. Private farms are either voluntarily associated in co-operatives or they gradually disappear (partially due to the migration

[1] One of the speakers argued that the Cuban experience speaks in favour of co-operatives as the basic element of change in agriculture. I have spent three months in Cuba as an economic adviser and I do not agree with his conclusion. The great landed estates, which were previously either plantations or cattle-breeding farms, were indeed not divided among farm workers (this was absolutely correct since they have been farm workers for generations and had neither any idea of how to manage a private farm, nor any craving for land). These estates have in fact not been transformed into co-operatives; indeed they are state farms with workers' self-management, much like our State Agricultural Farms. Genuine co-operatives were established in estates which had a production profile close to ours and in which land was leased to tenant farmers. The creation of co-operatives was in this case made much easier by a tremendous increase in the incomes of the tenants who previously had to repay two-thirds of their income as rent and who now keep it all (as far as I know, there are no gardening plots in these co-operatives).

of the young to the cities), while the land is taken over by the state for a compensation. It should be noticed that this process of state take-over of declining farms encounters serious difficulties. What appears most difficult is the decision on whether to take over an ailing farm, or continue to prolong its existence through some form of relief or assistance. There is also the problem of just compensation for the owners of such farms. Finally, provision must also be made to make the best use of these farms, which are generally fairly small. At this point there also arises the problem of creating incentives for farmers to hand over their land in an orderly manner, such as offering sufficiently attractive compensation for more prosperous farms which are adjacent to impoverished ones taken over by the state, in order to establish larger state farms. These are the problems on which agricultural economists should focus.

I cannot share one speaker's disappointment over the economists' failure precisely to foresee our agricultural system in 1980. Outlining general development paths without venturing into detailed forecasting of agricultural relations in the distant future seems to me a reasonable approach. However, it must be noticed that even within the framework of the putting-out system the small-scale commodity economy harbours a contradiction which may cause problems in the long run. What I have in mind is the long working day in this type of economy which will be increasingly hard to accept as living standards increase. This very factor will in the long run favour the transformation of the small-scale commodity economy into a large-scale one.

In the long term, this transition will also be facilitated by development of the national economy as a whole, leading to greater investment capacities. A much bigger accumulation fund will make it easier to finance the tremendous cost of collectivization of the agricultural sector. If this operation were to be accomplished in the near future, however, then it could either lead to a significant decrease in other productive investment—and thus to a fall in the rate of economic growth—or to a drop in consumption and hence also in the living standards of the population.

Finally, I would like to comment on the relatively small growth in productivity per worker employed in private agriculture. In consequence, productivity growth in agriculture is much lower than in industry, which allegedly is a bottleneck in the development of the socialist economy. First of all, it must be stressed that in a socialist economy growth in labour productivity is not an end in itself. It is, indeed, the objective of the capitalist since it has a direct bearing on his profits. In a socialist economy, however, increasing productivity of labour is only a means of increasing the national income and consumption per head of population.[2]

If the rate of growth of national income is not limited by shortage of labour, but by limited supply of raw materials (the supply of agricultural output included), as is the case in Poland, then faster productivity growth in agriculture leads to greater migration of labour to non-agricultural sectors without increasing their output. Faster productivity growth in agriculture would in this case not lead to faster growth of the national income and consumption, but to shorter working hours in the non-agricultural sectors. This of course creates a tendency to level the production cost of food and manufactures: employment in agriculture falls and that in industry grows, while the output of both sectors remains unchanged. If such a tendency fails to materialize, it does not necessarily follow that the prices of food must rise in relation to manufactures, since (should such need arise) this trend could be offset by turnover taxes and subsidies.

It is therefore not necessary for agricultural policy to be subordinated to the objective of the highest productivity per worker employed in agriculture. It should rather follow the principle of maximizing yields per acre of farm-land. The resulting faster growth in agricultural output would allow for faster development of the whole economy, in which the supply of raw materials (including agricultural output) acts, as I have already pointed out, as the real barrier to development.

It must also be mentioned that shorter working hours *in agriculture*, which I regard as the most essential factor in transforming the small-scale commodity economy into a large-scale one, will act towards *increasing* the cost of farm output. In this sense it will offset the effect of higher productivity of labour. The same effect will be produced by a higher capital–labour ratio in agriculture.

It can therefore be concluded that under Polish conditions long-term agricultural policy should not be concerned so much with increasing productivity of labour in agriculture, as with increasing the output per acre of farm-land.

On the Causes of Economic Delinquency[1]
(1962)

1. Economic delinquency is generally studied from the point of view of losses which it brings to the economy and to all consumers. However, its scope and present nature—organized economic delinquency with participation of the management of state enterprises—make it a first-rate political issue. We witness the emergence of a stratum of the criminal establishment which probably has a significant share in the purchase of cars or construction of residences. The resulting shifts in the distribution of national income are all the more glaring in that the dispersion of legal incomes in Poland is exceptionally small in all cross-sections: urban–rural, white collar–blue collar, management–workers. Against the background of relatively small income-differentiation in industry and agriculture illegal incomes stand out ostentatiously. Under these conditions fighting economic crime ceases to be merely a normal corrective in economic life, but also becomes a necessary condition of the achievement of socialism.

The analysis of factors which promote economic delinquency in the socialist system is not merely essential to its overcoming. The answer to the question on how this phenomenon has come into being is also essential since it is often maintained that economic delinquency is inherently linked to the nature of the socialist system and that 'master's eye makes the horse fat'. As is often the case in comparisons between socialism and capitalism, the latter is seen in terms of its early nineteenth-century features, when indeed the 'master's', i.e. the individual entrepreneur's eye, would 'make his horse fat'. However, it must be remembered that this entrepreneur, 'working on his own', is nearly a relict of the past, and that today's capitalism is dominated by large concerns in which the 'masters' are mere shareholders and whose operation is in the hands of managers. Although it is often supposed that these managers have a share in the profits of their concerns, the things are not, as I have shown elsewhere, the way they appear. Of course the manager of an enterprise which belongs to a concern

follows the objective of increasing its profits, but his main incentive is to keep his well-paid job.[1]

The Polish Academy of Sciences' Research Committee on Social Issues of People's Poland started a project on economic delinquency. Within the framework of this project Jacek Marecki made an extensive study which appeared in *Kultura i Społeczeństwo* (6/3 (1962)). Although it does not give a definitive answer to the question of what is at the roots of economic delinquency in its present form, his study induced me to put forward a working hypothesis which I would like to share with my readers. Further studies will of course be required to confirm it; as we shall see, these would have to examine not only the present position of economic crime, but also the past dozen years of its history.

2. My hypothesis rests essentially on the fact that the origins of economic delinquency in the socialist system (and not only in Poland) can be traced to that stage of its development in which the emphasis is laid primarily (if not uniquely) on rapid expansion of output. This is so, for instance, in the period of forced industrialization, such as a large part of the Six-Year Plan, 1950–5 in Poland. This stage is characterized by the following phenomena which contribute to economic delinquency:

(i) The basic task is the fulfilment of the production plan. Costs and quality are of secondary importance. As a result all attempts to control these aspects of enterprise activity are completely neglected. Because of the sellers' market, buyers cannot be fussy in their purchases. Misuse of materials and reducing the quality of stocks cannot be revealed by a lack of purchasers.

(ii) Because of widespread shortages, it is much easier to sell articles stolen from enterprises (the so-called 'leaks'), and at high prices, too.

(iii) As a result of the high share of investment in national income and the lag between the development of industry and that of agriculture, real wages tend to fall behind the potential of the economy.

The first two factors facilitate economic delinquency while the third one gives rise to it. At this stage of development economic

[1] See 'Some Comments on the Organization of an English Concern' [*Collected Works*, vol. iii].

delinquency is rather primitive and generally unorganized. Objective circumstances require neither great skill nor organization. But the extent of this delinquency is enormous. This situation is characterized by the saying 'There are no thieves, it's only common people who steal.' Hence comes the tolerant attitude of society at large to these abuses, which are regarded widely as a legitimate means of supplementing low wages. Moreover, in this period there emerges the network of intermediaries and fences who pick up and resell goods stolen from enterprises. As we shall see, the existence of this network, the great numbers of those involved in stealing and corruption, as well as the tolerant attitude of the population, jointly contribute to making economic delinquency a lasting phenomenon.

3. In the next phase of development the above factors, although not entirely eliminated, are at least greatly attenuated. Increased attention is paid not to the volume of output, but above all to its quality and cost. Simultaneously, control over the enterprise is being strengthened, even though it still fails to keep pace with development in the forces of production. Stock control is insufficient and there is still no effective control over the weight and quality of goods shipped out of the enterprise by an independent inspection agency. With a relative saturation of markets, trade is more selective in its purchases of goods. This saturation makes it also more difficult to sell stolen goods. Finally, real wages increase significantly due to a drop in the relative share of investment in national income and the progress achieved in agriculture.

It would seem that economic delinquency should disappear with the elimination of its causes. Unfortunately, reality has as usual appeared to be more complex and perverse. There emerged new forms of economic delinquency which were better adapted to the improved, but still imperfect, control. Instead of an individual amateur, on the stage of economic crime there appears an organized group which far better protects itself against control. Such a group is not discouraged by increasing difficulties in selling stolen goods; the higher per capita turnover which it can secure for its members compensates for lower prices in illegal deals (anyway, the sale of 'saved' inputs is not always involved; it is unnecessary, for instance, in cases of cheating the farmer at the purchasing counter, or the consumer in retail trade). Finally, an

improvement in living standards could, together with improved control, drive out of business the amateurs, but not the more committed 'professionals' of the present day.

These are facts. What are their sources? What caused one wave of crime to be replaced by another? Who has filled the vacuum created by partial elimination of the 'individual' forms of delinquency? The origin of criminal groups may be attributed on the one hand to the activities of the more committed individual criminals; on the other hand, it is instigated by the network of fences and intermediaries. When economic delinquency becomes more difficult, the more active criminals establish links with those who hold such posts as storehouse superintendent, accountant, managing director, etc.; intermediaries and fences also attempt to corrupt these persons.[2] This process of organizing criminal groups takes place in the atmosphere of social tolerance inherited from the earlier period.

The criminal group can comprise either people with strategic functions in the enterprise, or its whole staff. In the latter case most of the members of the group are 'small fry', but are nevertheless organized.

The malversations are then committed in such a way that the probability of their coming to light is very slight. The stress is on transfer of the 'surplus' without leaving any trace of it in the books. Such is the case of fraud practised in the purchase of slaughtered livestock. The purchasing agents classify it below its real value and pay to the peasant a sum which is smaller than the one for which they account when turning the livestock in. However, they must give a receipt for this smaller sum and this does not check with the sum they receive when they turn the livestock in. One could of course have a double system of accounting books, but this would be a 'cheap' trick since the receipt in farmer's hands could one day come up as proof of fraud. How do professionals handle this? Agents come to terms with some peasants: they classify their livestock above its value and share profits. In this way the 'surplus' is transferred. This is costly since profits must be split, but no proof remains.

Reduction of risk through more sophisticated forms of crime which, however, requires splitting gains among a larger number

[2] It must be added that the groups of 'insiders' appear much sooner in the co-operatives than in the state enterprises.

of persons, makes harsh repression less effective. The culprit can always console himself with the thought that he might as easily have been hurt in an accident.

The evolution of economic delinquency resembles the process of concentration in a capitalist economy. Under changed conditions the petty criminal can barely make it, although he does not disappear altogether. His place is taken by an organized criminal group just as the capitalist factory replaced the impoverished artisans. In some cases the analogy is complete. It appears that the heads of organized crime, who were also top managers of enterprises, were known to be very vigorous in their fight against petty crime. They played Katonius while destroying their small rivals.

It must also be said that, again much like the artisan in capitalism, an individual criminal in favourable circumstances can still prosper. As an example one can quote the escorts on delivery service to shops, whose frauds are made easier by the fact that deliveries take place during the shop's working hours when it is extremely difficult to control the delivered goods properly.

4. As we can see, control does not catch up with the activities of delinquent groups. It cannot be ruled out that in at least some cases their representatives enjoy sufficient influence to defeat attempts to improve control. Such resistance can always be dressed up effectively as opposition to bureaucracy and saving on costly control regulations. For example, for years the setting up of a quality inspectorate independent of enterprise management has been under consideration, but nothing has come of it. Of course, there may be other motives for opposition to such controls. Even those who are not economic delinquents have an interest in obtaining a high rate of financial accumulation through easy 'savings' of materials and labour, reducing the quality of output. In any case, the introduction of more rigorous controls is not a matter of reason alone, but a struggle against various interest groups.

However, economic delinquency will not be combated without more stringent controls, to which adequate resources must be devoted. Just as for each factory output, capacity utilization, and new investment are planned in advance, so appropriate forms of control over an enterprise's activity by agencies independent of it

must also be planned. This control should be supplemented by the vigilance of the workers' council representing the interests of the work-force, which (unless it is itself a part of organized crime) is opposed to those of the delinquent group.

The struggle against economic delinquency may be made easier by changes recently observed in social attitudes. The formation of organized delinquent groups, whose members are not the poor, but the 'upper class' of crime, leads to a *sui generis* class conflict between these groups and the broad masses of the population, making it ever more hostile to economic delinquency.

A Comparison of Manual and White-Collar Worker Incomes with the Pre-War Period[1]

(1964)

I

A comparison between incomes of manual and white-collar workers in 1960 and in 1937 was conducted by the Polish Academy of Sciences' Research Committee on Social Issues of People's Poland by Lidia Beskid with my assistance.[1]

This research project called for tedious statistical work which had to pass through the following stages.

1. Estimation of global incomes of manual and white-collar workers in 1937, as well as of the manual and white-collar populations (including their families), split into professionally active and non-active subgroups. This allowed the calculation of income per head and income per employee in each of the two subgroups and for the whole working population.

2. Estimation of the average income of manual and white-collar workers, as well as the average income of all persons gainfully employed in 1960. Knowing the ratio between the professionally active and non-active population we could therefore calculate the average income per head of the professionally active population.

3. Calculation of the retail price index for goods and services for 1960 taking 1937 as the base year.

4. Calculation of real income per head of the professionally active population, as well as separately for manual and white-collar workers.

5. Estimation of the impact on the indices of real incomes of changes in taxation, in social security premiums and benefits, as well as in incomes other than wages.

[1] Part of the detailed results of this analysis was already published in *Przegląd Statystyczny*, 10/3 (1963); the rest will be published there as well [for details of these publications, all by L. Beskid, see p. 353–5, this volume].

6. Estimation of the rate of employment in 1937 and the resulting indices of the real income of professionally active manual and white-collar workers in 1960 (1937 = 100).

7. Calculation of the same index for manual workers, excluding low-paid jobs which existed before the War but have by now largely disappeared (household servants and hired labour in artisans' workshops).

8. Calculation of the respective indices for workers employed in manufacturing and construction industries, as well as for all other workers (again excluding household servants and hired labour in artisans' workshops).

We shall now discuss the calculations carried out at each of these stages.

II

1. To start with, we took the estimate of total wages of manual and white-collar workers outside agriculture in 1929, made by Ludwik Landau, as well as his estimate of the manual and white-collar populations in that year. These estimates were adjusted after taking into account results of later studies, including those of Landau. The total wage bill in 1937 was calculated by multiplying the respective wage bills by the corresponding indices, or directly from the data available for that year. This calculation is in many aspects hypothetical but its result was checked as follows. In 1937 there existed the so-called Work Fund which was financed through contributions equal to 1% or 2% of wages for various groups of employees. We were therefore able to estimate the revenues of this fund corresponding to our estimate of the total wage bill of manual and white-collar workers. Thus calculated, revenues of the Work Fund were within a 2% margin of error compared with their actual value.

The approximate numbers of manual and white-collar workers were calculated on the basis of the percentage growth of these two subgroups compared to 1929. Because the indices of population growth involved here are rather small, these estimates did not significantly affect our calculations of average incomes. Finally, the proportion of professionally active and non-active population was based on the census of 1931. We thus calculated per capita income for the whole professionally active population, as well as for manual and white-collar workers.

It should also be noticed that in the calculation of average incomes the army and the police were omitted since no data were available for either of these groups in 1960.

2. For 1960 the average income per worker outside agriculture was calculated on the basis of the wages actually paid out and the actual employment, assuming that the number of employed corresponded to the number of the professionally active (it was assumed that small temporary unemployment was offset by some employees having two jobs). This assumption allowed us to calculate the per capita income of the professionally active population; the preliminary data of the 1960 Census were used for this purpose.[2] The estimate of the average per capita income for manual and white-collar workers respectively was based on a study of the structure of employment according to income group conducted by the Central Statistical Office.

3. The index of change in retail prices for goods and services in 1960 (1937 = 100) was calculated for two variants: one for a fairly disaggregated structure of expenditure in 1937, and the other for its structure in 1960. We thus obtained two indices: one equal to about 900 and the other to about 1100 (1937 = 100). Due to a radical change in the structure of expenditure (in real terms), this was not surprising. For our calculations the geometric average of these two indices was taken, equal approximately to 1000 (additional examination showed that this index is appropriate both for manual and white-collar workers).

4. On this basis, it was possible to calculate the indices of real incomes in 1960 (compared to 1937). A per capita index of 156 was obtained for all employed outside agriculture and a slightly higher one (158) per person employed. The index of income for professionally active manual workers was 205, while that for white-collar workers was 81—a serious drop.

5. From a comparison between taxes and social security contributions and benefits before the war, and taxes (at present employees do not contribute to the social security fund), social security

[2] For the time being, only the data on total employment are available.

benefits, and payments from the company fund in 1960, it follows that the index of per capita income for all employed must be further increased by 12%; from 156 to 175. It is assumed that these benefits are evenly distributed among the professionally active population. It should also be noted that the data on sick-pay benefits before and after the war do not include non-cash benefits. Retirement pensions are also excluded from our calculations, and hence pensioners are not included in the professionally active population. The index of income per person employed was corrected in a similar way, reaching 177 for the whole professionally active population, 230 for manual workers, and 90 for white-collar workers.

6. The starting-point for estimating employment in 1937 was again data on employment in 1929. At the first stage of our calculations the numbers of professionally active persons were estimated. At this stage we turned to estimating unemployment in 1929. For manual workers, the 1931 figures were used, as well as the numbers of registered job-seekers. For white-collar unemployment the estimates of S. Lewe were used. We could thus estimate the number of the employed in 1929. Using the same method which enabled us to pass from the total wage bill in 1929 to that of in 1937, we deduced the corresponding figure of employment in 1937. This estimate, and the earlier one of the number of people professionally active in 1937, give the percentage of unemployment in that year. It was nearly 24% for manual workers and 13% for white-collar workers, their respective rates of employment being 76% and 87%. For 1960 it was already assumed that the number of professionally active persons was equal to actual employment (the rate of employment being 100%). The indices of real income per professionally active person could therefore be calculated by multiplying the index of real income per employed person by the rate of employment in 1937. The following indices were obtained: 175 for manual workers, 79 for white-collar workers, and 139 for the whole gainfully employed population. The impact of eliminating unemployment on changes in income is, of course, not included.

7. In order to eliminate significant disparities in the structure of wages of manual workers, due to the impact of low wages of household servants and hired labour in artisans' workshops, i.e.

occupations which by 1960 have largely disappeared, the pre-war incomes per gainfully employed person were calculated without these two subgroups. Income per person gainfully employed in 1960 were calculated in turn for the socialized sector alone, thereby also excluding these subgroups. This exclusion results in a significant drop in the index of real income per employed manual worker, down to 145.

8. Finally, through comparison between wages of manual workers employed in 1960 in the so-called industrial sector (inclusive of construction) and average wages, inclusive of mining and construction (in factories of categories I–VII before the war), we obtained the index of real incomes per person employed for this category of manual workers. It is equal to 154 (again adjusted for taxes, social security contributions and benefits, excluding retirement pensions and other additional incomes).

Since the relevant data on employment also exist, it was possible to calculate the index of incomes for workers employed outside industry (with the exception of household servants and hired labour in artisans' workshops). This index is much lower than the one for industrial employment and equals 129. The results of our calculations are presented in Table 1.

As we can see, between 1960 and 1937 living standards of the working population have increased significantly. It is the result

Table 1. *Indices of Real Incomes for Manual and White-Collar Workers outside Agriculture in 1960 (1937 = 100)*

Real incomes	Manual workers	White-collar workers	Total employment
Per head of population	x	x	175
Per person professionally active	230	90	177
Per person employed	175	79	139
Per person employed (household servants and hired labour in artisans' workshops excluded)	145	—	—
Per person employed in manufacturing	154	—	—
Per person employed outside manufacturing (household servants and hired labour in artisans' workshops excluded)	129	—	—

of a very large growth in living standards of manual workers, which nearly doubled, and a certain fall in that of white-collar workers. This growth is largely due to an increase in the rate of employment; income growth per employee was much less. It is still quite high for manual workers, but for white-collar workers there is a significant drop of about 20%. Finally, if the incomes of household servants and hired labour in artisans' workshops are excluded, then the index for manual workers' incomes is reduced to 145. This index in turn results from a 55% increase for manual workers employed in the industrial sector, and about 30% growth for those employed outside industry (again excluding household servants and hired labour in artisans' workshops). The respective indices, which do not take into account incomes of the 'pariahs' of the pre-war period, reflect the approximate evolution of real incomes in the same type of occupation.

An important increase in the income of manual workers and a large fall in that of white-collar workers has led to a radical levelling of incomes. The ratio of the average income of white-collar workers to that of manual workers is given in Table 2.

A white-collar worker, who in pre-war Poland belonged to the privileged classes compared to the manual worker, in 1960 earned on average little more than the manual worker.

Summing up, a very significant increase in the average living standards of the working population was accompanied by much more modest increases in earnings for comparable work. For manual workers as a whole this growth is 75%, while average earnings of white-collar workers fell by about 20%. In consequence, the disparity between the average earnings of these two

Table 2. *Ratios of Income of White-Collar Workers to Manual Workers outside Agriculture (per person employed)*

	Ratios 1937	Ratios 1960
Income of white-collar workers to income:		
of manual workers as a whole	2.63	1.18
of manual workers excluding household servants and hired labour in artisans' workshops	2.26	1.12

groups, which was very large before the war (indeed much greater than in the developed capitalist economies), is now insignificant.

In order to complete this picture of the changes in incomes let us also provide some information on growth in the living standards of the farming population, which was not included in our investigation. According to other studies, the living standards of this section of the population increased in this period by 2.5 times.[3]

The results obtained, doubtlessly interesting in themselves, also shed some light on the evaluation of current living standards by various groups of the population who compare them to their pre-war standards. It seems that in this field there exists the following sociological 'law': on the whole people compare their real incomes with corresponding incomes before the war, without taking into account the elimination of either unemployment or very low-paid work. If someone was not unemployed before the war, or if he was too young to take up employment, then in his judgement of the situation he would take no notice of the improvement in the employment situation. And even if he was unemployed, but for a short period only, he would still compare his present income with that at full employment before the war. The same is true of the increase in the average income of manual workers due to the elimination of low-paid work. Those who did not belong to these underprivileged classes before the war have no personal interest in their elimination. And those who have experienced social promotion have become different persons and compare their incomes with the pre-war incomes of those employed in their current professions. I have heard that in Elbląg there is not a single pre-war inhabitant, yet its present inhabitants persistently compare their present material situation with that which existed in this city before the war.

It now becomes clear why the popular perception of income changes is less favourable than the actual increase in living standards. First of all, white-collar workers feel themselves to have been severely wronged. As for manual workers' incomes, these have appreciated greatly even if we take comparable work as a starting-point. But this increase is considerably less than the very great

[3] See L. Zienkowski, *Poland's National Income in 1937–1960*, Warsaw, PWE, 1963 [in Polish].

increase in the average living standards of the working population. Moreover, it should be borne in mind that: (i) even among manual workers, the increase in real incomes for the same work is rather small for those employed outside industry; and (ii) among industrial workers, more skilled and experienced workers have gained less than younger and unskilled workers.

This kind of change in the incomes of non-agricultural workers and its influence on the attitudes of the urban population is not a specifically Polish phenomenon. These changes are, and will continue to be characteristic of the development of socialist countries starting from a low level of economic development. In these countries even a considerable increase in consumption of the masses is largely absorbed by increases in the very low standards of living in agriculture, by the costs of the rural population's migration to better-paid urban occupations, and by the elimination of unemployment and low-paid work in the urban areas (where their existence is a form of disguised unemployment). Under these conditions, only a small part of the overall increase in consumption can be allocated to raising real wage rates. Nevertheless if, as is quite likely, wage rates are increased, this is bound to be accompanied by a substantial fall in the real earnings of white-collar workers. The resulting popular perceptions, which have been examined above, can cause serious difficulties during the socialist development of less developed countries. Nevertheless, such an incomes policy is the only possible pattern of economic development that is based on principles of social justice.

EDITORIAL NOTES AND ANNEXES

PART 1
Growth Theory

Introduction to the Theory of Growth in a Socialist Economy

[1]
The book was first published in Polish as *Zarys teorii wzrostu gospodarki socjalistycznej*, Warsaw, PWN, 1963. The 2nd edn. appeared in 1968 and the 3rd in 1974. Ch. 1 of the 1st edn. was republished as 'Dochód narodowy: definicje i założenia', in *Materiały do studiowania ekonomii politycznej socjalizmu: wybór tekstów* (*Readings in the Political Economy of Socialism*), Warsaw, KiW, 1964, pp. 175–9; chs 1, 2, 4, 6–8, and 11, of the 2nd edn. were republished as 'Definicje i założenia teorii wzrostu', in H. Chołaj, R. Cheliński, and M. Nasiłowski, *Ekonomia polityczna socjalizmu: wybór tekstów* (*Political Economy of Socialism: Selected Readings*), Warsaw, PWE, 1971, pp. 356–409.

The 1st edn. of the book had the following translations: Czech (*Náčrt teorie růstu socialistické ekonomiky*, Praha, Nakladatelství Politické Literatury, 1965, pt. I); Japanese (*Shakai shugi keizai seichoron gaiyo*, Tokyo, Nihon Hyoronsha, 1965); Hungarian ('A szocialista gazdaság növekedési elmélete', in M. Kalecki, *Vállalatvezetés—tervezés—gazdasági növekedés*, Budapest, Közgazdasági és Jogi Könyvkiadó, 1966, pt. II); Italian (*Teoria dello sviluppo di una economia socialista*, Roma, Editori Riuniti, 1967); and Spanish (*El desarrollo de la economia socialista*, México, Fondo de Cultura Económica, 1968; 2nd edn., 1974). In 1967 an English translation was produced as a textbook, *Introduction to the Theory of Growth of Socialist Economy*, Warsaw, SGPiS, The Advanced Course in National Economic Planning, Teaching Materials, vol. 29; it included some of the revisions and developments which Kalecki intended to introduce in the 2nd Polish edn. of the book. Shortly after it appeared, there followed its English translation, *Introduction to the Theory of Growth in a Socialist Economy* (Warsaw, PWN/Oxford, Blackwell, 1969). Subsequent translations were based either on this translation or on the 2nd (or 3rd) Polish edns. The following translations were published: Russian (*Oczerk tieorii rosta socyalistitcheskoy ekonomiki*, Moscow, Progress, 1970); French (*Théorie de la croissance en économie socialiste*, Paris, Sirey, 1970); Romanian (*Schiţă a teoriei creşterii economiei socialiste*, Bucharest, Stuntifica, 1972); Portuguese (*Introdução à Teoria do Crescimento em Economia Socialista*, Lisbon, Perlo, 1978); German ('Wachstumstheorie der sozialistischen

Wirtschaft', in M. Kalecki, *Theorie des Wachstums und der Planung in der sozialistischen Volkswirtschaft*, Baden-Baden, Nomos, 1982, pt. II); and Thai (*Botnam waduaytisdee karnchareontangsethakit nai rabob sangkomniyom*, Bangkok, Thaiwathanapanich, Chulalongkorn University, 1984). The 3rd English edn. was published in M. Kalecki, *Selected Essays on the Economic Growth of the Socialist and the Mixed Economy* (Cambridge, CUP, 1972, chs. 1–11); this selection was then translated into Spanish (*Economia socialista y mixta*, México/Madrid/Buenos Aires, Fondo de Cultura Económica, 1976); the 2nd Hungarian edn., 'Bevezetés a szocialista gazdaság növekedési elméletébe', published in M. Kalecki, *A szocialista gazdaság működéséről: válogatott tanulmányok 1956–1970* (Budapest, Közgazdasági és Jogi Könyvkiadó, 1982, ch. 10), also followed the respective chapters of the 1972 CUP edn.

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The Soviet economist G. A. Feldman is regarded as the forerunner of the theory of growth of a socialist economy. His two-sector models of economic growth drew upon the theoretical heritage of the 1920s, when Soviet economists who worked on national economic planning had to address themselves to the problems of economic growth. (Feldman model is discussed in E. Domar, 'A Soviet Model of Growth', in his *Essays in the Theory of Economic Growth*, Oxford, OUP, 1957.)

In the 1930s and 1940s, the problems of aggregate models of economic growth were studied by Western economists. But the reliable economic statistics necessary to test these models and apply them in practice, were not available until after the Second World War, when statistical series on the volume and structure of national output, capital stock, employment, and trade provided the growth theorists with more solid empirical foundations. The most general growth equation for a one-sector economy

Rate of Growth = Rate of Productive Accumulation/Capital–Output Ratio

was first put forward by Sir Roy Harrod (see his *The Trade Cycle*, Oxford, Clarendon Press, 1936), and subsequently by Evsey Domar (see his 'Capital Expansion, Rate of Growth and Employment', *Econometrica*, 14/1, 1946). The formula was already implicit in Kalecki's 1937 paper (see 'A Theory of the Business Cycle', in *Collected Works of Michał Kalecki*, vol. i, Oxford, OUP, 1990, pp. 529–57). In 1944 he introduced the notion of an equilibrium rate of economic growth:

The question of the equilibrium level of private investment at which we should aim in the regime of full employment requires

some preliminary remarks about the concept of the degree of utilization of equipment, by which we mean the ratio of actual output to the maximum capacity of equipment. . . . To maintain the degree of utilization of equipment, the capacity of the latter must expand proportionately to the increase in the working population and the productivity of labour. This gives us the clue as to what should be the level of private investment. Private investment must be at a level adequate to expand the capacity of equipment *pari passu* with the increase in working population and productivity of labour, that is proportionately to full employment output. ('Three Ways to Full Employment', in *Collected Works of Michał Kalecki*, vol. i, p. 365–6.)

In the early 1950s, Kalecki used explicitly an aggregate growth equation similar to the Harrod–Domar equation, in connection with his work on successive volumes of the *World Economic Report*, which were prepared under his direction in the United Nations Secretariat. According to Stanisław Braun, a friend and close associate of Kalecki at the UN Secretariat, Kalecki himself wrote the summary of economic development in the socialist countries in 1952–3. In the summing up of his analysis, Kalecki stated:

The decline in the proportion of resources allocated to investment which is planned in all countries of the area will tend to reduce the rate of increase in the national product. Indeed, on the assumption of full utilization of equipment, the rate of increase in the national product is proportionate to the share of net investment in the product, if the relation between net investment and the increment in productive capacity remains constant. This will be seen from the following formula:

Rate of Increase in National Product = (Net Investment/National Product) × (Increment in Productive Capacity/Net Investment)

It follows from this formula that the effect of a reduced share of investment in national product may be partly offset by policies tending to increase the effectiveness of investment in terms of adding to productive capacity. Such policies have indeed been put into operation. (*World Economic Report 1952–1953*, Lake Success, UN, 1954, p. 44. In a footnote to this equation Kalecki explains that, since on the right-hand side of the equation the numerator of the first fraction is the same as the denominator of the second fraction, the formula boils down to an identity between the growth of productive capacity and the growth of aggregate output. This equation therefore implies full capacity utilization.)

In his 1955–6 paper 'Dynamics of Investment and National Income in a Socialist Economy' (see his *Collected Works*, vol. iii, pt. 4) Kalecki extended this formula to take into account the effect on economic growth, on the one hand, of the losses of productive capacity due to ageing and wear and tear and, on the other hand, of improvements in the utilization of existing capacity. In the subsequent two articles, published in 1957 and 1958, he made the relationship between the rate of growth in a socialist economy and investment more specific, linking the construction period of investment with the growth of national income and consumption (see ibid.). As with Feldman, however, the main source of inspiration for Kalecki's research on economic growth in a socialist economy was his direct experience of economic planning and, especially, his work on the first perspective plan for Polish economic development in 1961–75. This experience resulted in a series of articles which gave rise first to his essay on the 'Problems in the Theory of Dynamics of a Socialist Economy' (see ibid. and note [1], p. 358 of that volume), and then to Kalecki's *Introduction to the Theory of Growth in a Socialist Economy*. A close link between his approach to the theory of growth under socialism and socialist long-term planning is also reflected in the title of a paper which Kalecki was to read to the Third Conference of Polish Economists in 1960: 'Teoretyczne zagadnienia wzrostu gospodarczego na tle polskich doświadczeń planistycznych' (Theoretical Problems of Economic Growth in the Context of the Polish Experience of Planning); in fact, the conference did not meet because the authorities expected it would criticize economic policy of the government and its tardiness in introducing economic reforms.

Indeed, the *Introduction* can be interpreted as generalizations about two sets of problems. On the one hand it deals with the methodological problems in economic planning, e.g. how to calculate national income and its components, what output indicators or prices should be used, etc. On the other hand it also puts forward a method of determining the rate of economic growth in the plan, allowing for technical and organizational barriers to growth, raw-materials supply constraints, problems in balancing foreign trade, and the trade-off between current and eventual future consumption.

During the academic years 1961–2 and 1962–3 Kalecki delivered a series of lectures and seminars at SGPiS on the problems of economic growth in socialist economies. In May 1962 he gave a course of lectures and seminars on the same subject at the Social Sciences Faculty of Manchester University. Finally, in Sept. 1962, he gave two lectures at the Institute of Social Sciences and the Institute of World Politics and

Economics in Belgrade, where he outlined the conclusions of the *Introduction*, together with a graphic illustration of the 'Government Decision Curve', which he used to explain the procedure for rational determination by the central planners of their target rate of economic growth. (For an account of these lectures, see V. Tricković, 'Stopa rasta u socijalističkoj ekonomiji i njene determinente: osvrt na predavanje prof. M. Kaleckog', *Ekonomist*, 15/3–4, 1962, and, by the same author, 'Determinente stope rastu u socijalističkoj ekonomiji' *Medunarodni Problemi*, 14/4.) At the end of 1963, the *Introduction* appeared in print.

First reactions to Kalecki's theory

Kalecki's specific approach to the problems of growth theory in a socialist economy, together with his usual condensed style of exposition, made the *Introduction* rather difficult reading (for a closer examination of his approach, see J. Osiatyński, *Michał Kalecki on a Socialist Economy*, London, Macmillan, 1988, pp. 102–4). Even though it was preceded by his 1955–6 paper which he read at the Second Congress of Polish Economists, and which contained many ideas developed subsequently in his book, Polish economists were not yet ready to discuss the problems of socialist reproduction in such a language and style, devoid of long quotations from Marx and Lenin, and without repeated emphasis on the superiority of the socialist system over the capitalist one. The above-mentioned lectures at SGPiS gathered crowds of economists of all generations who were interested in economic theory and attracted by Kalecki's world-wide reputation. Yet these lectures only marginally contributed to a better understanding of his theory: only a few of his students overcame the difficulties of following the lecturer's thoughts and stayed to the end of his course.

At that time there gathered around Kalecki a group of economists about half of whom were his associates from the Planning Commission and the Economic Council. Others were mainly staff at the SGPiS and Warsaw University. This group undertook intensive research and teaching to develop and broaden the appeal of Kalecki's theories. Two seminar groups started regular meetings: one on Third World economic planning and development, and shortly after another one, on the theory of growth in a socialist economy. The latter was run jointly by Kalecki and Kazimierz Łaski.

The members of Kalecki–Łaski seminar absorbed Kalecki's growth theory relatively quickly. Several of them were fascinated by its apparent applicability as an analytical instrument in resolving various practical economic problems. Outside these circles, however, Kalecki's theory was not easily absorbed. Despite widespread recognition of its importance and originality, for a long time the *Introduction* had only three reviews and hardly encountered any criticism (see K. Łaski, *Nowe Drogi*, 18/4, 1964; for its English translations, see *Polish Perspectives*, 7/5, 1964; J. Beksiak, *Kultura i Społeczeństwo*, 8/3, 1964; Z. Dobrska, *Polityka*, 7/27, 1964). In 1966 Kalecki was awarded a First-Class State Prize for the book, and a year later, the book won the Oskar Lange Prize of the Polish Economic Society. On the occasion of the State Prize award two reviews of Kalecki's work appeared, of which that of Władysław Sadowski was particularly interesting (see *Życie Gospodarcze*, 21/80, 1966). One more review of the 2nd edn. of the *Introduction* (by J. Beksiak in *Nowe Książki*, 20/15, 1968) completes the list of its reviews published in Polish journals.

The author of the first foreign review of the *Introduction* was Alfred Zauberman of the London School of Economics. In a detailed presentation of Kalecki's theory, he emphasized its importance and methodological originality. Referring to the limiting nature of some assumptions, e.g. that of constant prices in transitional processes, the reviewer stressed its deep roots in the economic realities of centrally administered economies. One weakness of the theory was, in his opinion, the lack of any link-up between the theory of growth and the assumptions regarding the system of economic management. (This weakness had been pointed out earlier also by a Polish reviewer.) Despite these limitations, Zauberman considered Kalecki's theory to be 'a milestone in the literature on the subject' (A. Zauberman, 'A Few Remarks on Kalecki's Theory of Growth under Socialism', *Kyklos*, 19/3, 1966, p. 422).

The Russian edn. of the *Introduction* appeared with a preface by one of the most prominent Soviet economists and a member of the Soviet Academy of Sciences, Professor T. S. Khachaturov. The preface follows below in Annex 1.

ANNEX 1

Preface to the Russian edition of the *Introduction to the Theory of Growth in a Socialist Economy*[1]

T. S. KHACHATUROV

The author of the book under consideration is a well-known Polish economist and fellow of the Polish Academy of Sciences, Professor Michał Kalecki.

[1] *Otcherk tieorii rosta socyalistitcheskoy ekonomiki*, pp. 5–11; a footnote to the 'Preface' which informed the Soviet reader about Kalecki's governmental advisory posts and his position at the Economic Council, and in international economic organizations, is omitted here. Progress publishers' permission to reproduce this preface is gratefully acknowledged.

In the preface to the first edition of his book, Kalecki points to having concentrated upon only a few fundamental and relatively simple problems of the theory of economic growth. Indeed, in his work he discusses only some aspects of economic growth in general, and of economic growth of the socialist economy in particular.

Professor Kalecki focused mainly on selected macro-economic proportions which in a major part of his work are examined with the assistance of abstract mathematical models. For this purpose he uses a number of concepts concerning the volume of national income and its components, the foreign trade balance, the volume of employment, and the capital–output ratio. Some of these concepts Kalecki defines in a way which differs from their use in the Soviet literature. For instance, he includes depreciation in national income, which is therefore a 'gross national income', equal of course to the final output. He includes non-productive investment in consumption, and unfinished construction work in working capital. Although his definitions are known to be well substantiated, one cannot fully identify them with the categories used in our country.

Having established mathematical relations between the various categories, and having assumed certain measures of these relations, the author examines their functional interdependencies. This in turn enables him to draw his various diagrams and substantiate his general conclusions concerning the conditions for steady economic growth, its acceleration under large reserves of labour supply, the impact of such factors as raising capital–output ratio or foreign trade balance on economic growth.

On the basis of the established mathematical relations Kalecki shows, for instance, that accelerated growth of the national income must be accompanied by an increasing rate of productive accumulation [see equation (7), p. 20]. Let us notice that when the general efficiency of the economy improves, then faster growth of national income can take place at the same rate of productive accumulation, or this rate can even be reduced. On the other hand, there is no clear functional relation between rates of growth of national income and the rate of productive accumulation: growth in the share of productive accumulation can lead to an insignificant increase in the growth rate of national income, or it may not change it at all, since raising the share of accumulation in national income leads to a fall in the share of consumption, which will depress the productivity of labour. The mathematical relations should be supplemented by economic analysis of laws determining the development of production.

In other parts of his book [see pp. 17–18 and pp. 53–5] Kalecki points to the interdependence between technical progress and raising the capital–output ratio, i.e. the investment outlay necessary to produce an additional unit of national income. This interdependence is not only discussed in the text, but is also emphasized in the title of Ch. 7.

However, as the author himself admits [see p. 17], it does not need to take place at all. It all depends on the extent to which new techniques of production increase productivity of labour and the volume of output. If the latter is sufficiently large to outweigh additional outlay necessary to generate this production, then investment outlay necessary for the introduction of new techniques will lead to a reduction (instead of a rise) of the capital–output ratio. This is the very tendency which takes place at more advanced stages of economic development. With contemporary scientific and technical revolution, constant growth in the rate of technical progress depends on the reduction of the capital–output ratio. The long-term tendency of the falling capital–output ratio in the United States is very revealing in this respect.

The presentation of general concepts and examination of their interdependencies is necessary in studying the processes of economic growth. In the course of the last few decades, this problem has also been investigated by bourgeois economics. It is characteristic that this analysis has shifted from the study of micro-economic behaviour of individual 'economic agents' to macro-economic phenomena of the capitalist economy as a whole, encompassing such macro-economic concepts as national income, accumulation, total consumption, employment, and the processes of reproduction of the national economy as a whole, etc.

To some extent the influence of the Marxist theory of reproduction is reflected in such a macro-economic approach. However, the interest that bourgeois economists now take in dynamic macro-economic issues in no way implies that they are ready to question the basic notions of bourgeois economics, such as the theory of marginal utility, marginal productivity, diminishing returns, not to mention discarding them altogether. Macro-economic proportions and dynamics of the economy as a whole are examined from a purely quantitative point of view, as if these were mechanical processes, while essential features of the economy and its internal causal relations remain obscure. Deriving economic laws from mathematical analysis, without exhaustive examination of economic interrelations and social determinants of economic development, leads to forcing actual economic development into simplistic and primitive schemes.

Most contemporary bourgeois economists more or less follow the tradition of Keynesian economics. Both Keynes and his successors—A. Hansen, R. Harrod, E. Domar, and others—study the dynamics of the national income and its distribution between consumption and accumulation (and the resulting increase in output and employment) in order to establish conditions which are necessary for steady economic growth. These enquiries have led to the discovery of the so-called acceleration and multiplier principles, and to many econometric models which show quantitatively the determinants of economic equilibrium and balanced

growth. Those are the origins of the concepts of investment productivity, the capital–output ratio, the share of productive accumulation in national income, etc. Roy Harrod demonstrates that the rate of growth of output is equal to the quotient of the share of productive accumulation and the marginal capital–output ratio. This formula to a certain extent represents actual processes if these categories are given their proper social and economic meaning.

Let us notice that a similar formula can be found in Professor Kalecki's book (equation (7)) who, however, takes it further than Harrod by introducing additional limitations to it. In this context, let us recall here the well-known Cobb–Douglas formula, according to which the rate of growth in the social output is a function of investment outlay and of inputs of labour. Again, in this formula too, conditions of real production are to some extent reflected, yet it is merely a simplified scheme. This is not to imply that the search for a formula of economic growth is unscientific. The great importance that Marx attached to mathematical interpretation of economic phenomena is commonly known. Marx's famous schemes for expanded reproduction, based on scientific analysis of the conditions of realization, express in mathematical terms processes which actually take place in the capitalist economy. The theory of growth of the socialist economy should above all depart from extended analysis of Marx's schemes of reproduction, and not from abstract functions of production, all arguments of which are already predetermined instead of being themselves treated as unknown variables.

Soviet economists also express economic phenomena in terms of formal analysis; they construct models of economic development and discuss economic growth in mathematical terms. In the Soviet literature A. I. Notkin attempted to discover the value of absolute economic efficiency of investment, linking it not only to the volume of investment outlay, but also to the productivity of labour. But even in his equation it is not clear why the indices of investment outlay should be multiplied by those of labour productivity, and why weights attributed to each of these types of indices should be the same. The attempts to establish a relation between the rate of growth of national income and the share of productive investment in national income, and the efficiency coefficient, were also undertaken by the author of this preface. The interdependencies between growth factors have been studied in one way or another by W. S. Niemtchynov, W. W. Novozhylov, L. W. Kantorovitch, and other Soviet mathematical economists.

The problem is not whether we are to use these or other formulae, which more or less reflect actual relations, but whether they also reflect their true economic and social context and real rules of development, whether they contribute to scientific analysis of the laws of motion of the economy. The lack of socio-economic examination of their contents, displayed to a lesser or greater extent by the above formulae, reduces their scientific significance and limits the scope of their practical application.

In our opinion, all these critical comments apply also to the book of Professor Kalecki. Paying tribute to his contribution to the analysis of macro-economic indicators, essential to the explanation of general economic interrelations and proportions, one cannot fail to notice that his mathematical formulae are in most cases of an abstract and schematic nature, and any exhaustive analysis of their social and economic contents is missing.

In fact, a book which seeks to enquire into basic problems of growth theory in a socialist economy should above all deal with its specific socio-economic features, as well as its superiority over the capitalist economy. The analysis of growth factors in the socialist economy, which discloses the possibilities of accelerating this growth, is one of the objectives of political economy of socialism and other economic sciences which deal with the socialist economy.

The socialist economy's capacity for the attainment of high rates of growth is above all determined by socialist ownership of the means of production, an end to exploitation of man by man, and production geared directly to satisfying consumers' needs, i.e. the needs of the whole society. These factors constitute the foundation of macro-economic planning, which decides, among others, on the superiority of the socialist economy, and on the use of economic instruments as well as material and moral incentives for increasing the efficiency of social production.

The question is how to make the best use of all the opportunities offered by the socialist mode of production. This explains the great importance attached to economic reforms in all socialist countries. Is the pace at which these reforms are introduced to the systems of national planning of economic incentives, etc., not an important factor of economic growth? Should these important undertakings in the socialist countries be omitted in the analysis of determinants of economic growth under socialism?

Of course, the great impact that optimum proportions of the national economy have on the rate of economic growth, enabling the full use of the existing capacities and resources, is in no way questioned here. This impact is especially pronounced with respect to proportions of distribution between accumulation and consumption. There is no need to stress, however, that this is not limited to the problem of the share of accumulation in national income. Economic growth is clearly also influenced by the growth of consumption which affects growth in the productivity

of labour, especially when the socialist principle of remuneration linked to labour input is respected. Hence it is necessary to find the optimum ratio of accumulation to consumption, corresponding to each phase of development.

The proportions between Departments I and II of social production are also extremely important. They should be established in relation to growth rates of output, labour productivity, constant improvements in the structure of the national economy, and in the living standards of the population. A very important role is also played by the optimum industrial structure, compatible with requirements of technical progress.

Scientific and technical progress and its practical implementation also are important growth factors of the socialist economy. One must correctly select the most efficient directions of scientific and technical development, which should fully serve the needs of increased efficiency of social production. In this case economic calculation and economic analysis have the foremost role to play. One must also correctly assess the volume of outlay necessary for development of science. In developed capitalist countries it amounts to above 3% of the national income. The distribution of this outlay between basic research and development studies is also very essential.

However, the problem does not end here. It is necessary to plan the development of new technologies, to stimulate it through economic incentives, and rapidly and fully to use their effects in practical applications. This leads us to the problem of the system of management of enterprises, the rational organization of technological processes, and the scientific organization of work. All these factors have their impact on economic growth.

An exceptionally important role is played by skills of the labour force. No effort must be spared to increase them, to properly train the managerial staff, and to deploy it rightly. It is necessary to plan outlay needed for training and education of management, and increasing its professional qualifications. The economic efficiency of this outlay must be precisely assessed, including its social significance.

The enquiry into all these growth factors in the socialist economy is of an exceptional theoretical and practical importance. The identification of these factors, the way they influence the growth of the socialist economy, their optimum combination in accelerating growth, etc., all constitute the object of concern for scientists, managers, economists, and all working people. For an economist it is a matter of great importance to be able to provide comprehensive answers to these questions. Otherwise, it is difficult to reach practical conclusions that would go beyond the obvious.

Professor Kalecki's book presents us with a mathematical apparatus necessary to study the whole system of functional relations between different factors of production. However, this apparatus cannot replace the theory of expanded reproduction of a socialist economy. On the other hand, it must be admitted that the book throws light on a number of interesting and valuable relations. The mathematical analysis used by Kalecki may be of interest both to specialists who deal in more detail with the laws of expanded reproduction, and to those which apply these laws to the practice of economic planning.

This preface, written by one of the most prominent Soviet economists, indicates that the Soviet academic economists were prepared to receive the *Introduction* with reserve, and even coolly. The summary of the book in Khachaturov's preface Kalecki considered unfair; in a letter to Progress publishers he wrote:

Dear editor Pavlov,

Thank you for the proofs, which I return with some minor corrections. The translation seems to be very good.

Since the proofs include also the preface by a fellow of the Soviet Academy of Sciences, T. S. Khachaturov, I must let you know that I do not agree with him on a number of points. Among others, the Preface occasionally misrepresents the sense of my argument. For instance, [at the bottom of page 243] it is said that in my book technical progress involves a rising capital–output ratio, while actually the book is largely directed against such an idea (see e.g. pp. [17–18]). For me personally this is of no great significance as the reader will have the full text of the book and will be able to form his own opinion about it.

(Undated draft of the letter to the editor of Progress publishers surviving in Kalecki's files.)

T. S. Khachaturov's opinion was partially balanced by a favourable review of the book published in the journal of the Soviet mathematical economists which, however, only had a narrow readership. The reviewer considered the book an excellent and simple introduction to the theory of macro-economic modelling and suggested complementing Kalecki's theoretical considerations with empirical examples drawn from the economic practice of the socialist countries (see S. M. Wishnieye, 'M. Kalecki: Otcherk tieorii rosta socyalistitcheskoy ekonomiki', *Ekonomika i Matematicheskiye Metody*, 7/1, 1971).

In Czechoslovakia interest was quicker and more widespread, but again mainly among non-university economists. This was apparently associated with the considerable economic difficulties experienced in Czechoslovakia at the start of the 1960s, and the hopes of some

economists (mainly from the Czechoslovak Planning Commission and the Institute of Economics of the Czechoslovak Academy of Sciences) that Kalecki's theory might help them to diagnose the causes behind the failures in economic policy. (For a discussion of the attempts to test empirically Kalecki's model, undertaken by these economists, see pp. 271–2 below.)

In the early 1970s Kalecki's theory attracted great interest in the West. G. R. Feiwel published two articles which presented the *Introduction* in some detail (see his 'Towards a Theory of Growth of a Centrally Planned Economy', *Soviet Studies*, 22/1, 1970, and 'Michał Kalecki's Introduction to the Theory of Growth in a Socialist Economy: A Review Article', *Journal of Economic Literature*, 9/3, 1971). B. J. MacFarlane presented the main theses of the book in his article 'Michał Kalecki's Economics: an Appreciation' (*Economic Record*, 47/1, 1971). Comprehensive reviews of the book's English translation were published by R. F. Harrod in *Kyklos* (24/1, 1971), and by H. Flakierski in *Canadian Journal of Economics* (4/3, 1971). A review of the book's Spanish translation appeared in the Mexican journal *Comercio exterior* (19/12, 1969). Reviews of Kalecki's volume *Selected Essays on the Economic Growth of the Socialist and the Mixed Economy*, which were mainly devoted to the problems presented in the *Introduction*, appeared in *Economic Journal* (83/1, 1973), and in *Kyklos* (26/2, 1973).

Few reviews and scarcely any discussion of the *Introduction* in Polish economic journals in the years immediately after its publication were partly compensated by animated debates during Kalecki's university lectures, and especially at the above-mentioned Seminar on Socialist Growth Theory. The school of thought which consolidated around this seminar differed from other approaches to the theory of growth in a socialist economy due to its close links with the basic principles of long-term planning and its concern with improvement in the living standards of the population; this it considered to be the key objective and a yardstick by which the broadly conceived efficiency of the socialist economy was to be measured. Besides the inspiring role of Kalecki's theory and his moral integrity, the creation of this school of thought was promoted through the organizational efforts of his associates.

A good, although not exhaustive, illustration of this school's achievements is the output of the Seminar on Socialist Growth Theory. It was started at the SGPiS in autumn 1964 and was run until the end of the academic year 1967–8. It met every other Monday and was run jointly by Kalecki and Łaski. It was attended every year by about thirty economists, about half of whom continued to participate until the Seminar's end. About half of participants were Kalecki's associates from the Planning Commission and the Economic Council, and the rest were predominantly research students from Warsaw University and the SGPiS.

In its first year of operation the Seminar focused on studying Kalecki's *Introduction*. Among several papers discussed in the second year there were two by Władysław Sadowski, who was one of the first to examine the transition from one rate of steady growth to another (see his 'Change in the Rate of Economic Growth', *Ekonomista*, 51/6, 1958, and 'Acceleration of Long-Term Growth of the Socialist Economy', *Ekonomista*, 54/4, 1961 (both in Polish)), a paper which examined the applicability of the Cobb–Douglas function in explaining the economic development of post-war Poland (see M. Nasiłowski, 'Production Function as an Analytic Tool in the Theory of Economic Growth', *Ekonomista*, 61/5, 1968 (in Polish), and a study which investigated the relationship between the curve of production and the marginal recoupment period, used in Poland in the calculation of the efficiency of alternative investment projects (see C. Józefiak, 'Production Curve and the Marginal Recoupment Period', *Ekonomista*, 58/6, 1965 (in Polish)).

The 1966–7 academic year was dominated by discussions of extensions and improvements which Kalecki intended to introduce in the revised edn. of the *Introduction*, and which concerned mainly various aspects of the Golden Rule of Accumulation in the context of socialist growth theory. Possibly equally important, however, were the related debates on the choice of techniques of production under unlimited supply of labour. The problem had practical relevance for developing countries. Kalecki's arguments against M. Dobb (see his *Essay on Economic Growth and Planning*, London, Routledge & Kegan Paul, 1960) and A. K. Sen (see his *Choice of Techniques*, Oxford, Blackwell, 1960) were refined and developed by Z. Dobrska (see her *Choice of Techniques of Production in the Developing Economies*, Warsaw, PWE, 1963 (in Polish) and A. Müller (see his *Optimization of Techniques of Production in the Developing Countries*, Warsaw, PWE, 1966 (in Polish)).

In the final year of the Seminar's existence the debates focused mainly on problems of optimizing capital–output ratios and the life-span of capital equipment. They were examined thoroughly by W. Sadowski (see 'The Optimum Capital–Output Ratio and the Optimum Life-Span of Equipment', *Ekonomista*, 59/4, 1966; 'Technical and Restitution Optimum', *Ekonomista*, 60/3, 1967; and 'Steady Growth', *Ekonomista*, 61/4, 1968 (all in Polish)), and C. Józefiak (see 'Increasing Capital–Output Ratio under Unlimited Supply of Labour', *Ekonomista*, 60/7, 1967; 'Technical and Restitution Optimum under Steady Growth', *Ekonomista*, 62/4, 1969; and *Technical and Restitution Optimum in a Socialist Economy*, Warsaw, PWE, 1971 (all in Polish)).

The limited importance of the concept of optimum rate of capital accumulation was demonstrated by Joanna Gómułka and Stanisław

Gómułka (see 'On the Relative Nature of the Optimal Rate of Accumulation', *Ekonomista*, 60/4, 1967 (in Polish)). The relations between alternative classifications of technical progress, including that used by Kalecki, were in part reviewed and in part established by Alberto Chilosi and Stanisław Gómułka (see 'Technical Progress and Long-Run Growth', *Rivista di Politica Economica*, 59/3, 1969).

The work of the Seminar was preceded by publications of Kazimierz Łaski. His two articles ('The Influence of Foreign Trade on the Rate of Economic Growth', in *International Trade and Development—Theory and Policy*, Warsaw, PWN, 1966, and 'Temporary Deceleration of Growth and the Dynamics of Consumption in a Socialist Economy', *Ekonomista*, 57/4, 1964 (in Polish)), drew from Kalecki's theory and substantiated certain aspects of it. Łaski's book *An Outline of a Theory of Socialist Reproduction*, Warsaw, KiW, 1965 (in Polish), which until 1968 was used as a textbook, provided an introduction to Kalecki's theory and contributed to its systematization (see also K. Łaski, *The Rate of Growth and the Rate of Interest in the Socialist Economy*, Vienna/New York, Springer, 1972).

The output of Kalecki's Growth School also includes a study by Wiktor Herer, *Growth Processes in Agriculture*, Warsaw, PWE, 1970 (in Polish), and some papers which were not discussed at the Seminar's meetings but were prepared under Kalecki's or Łaski's direct supervision and which aimed at extending Kalecki's theory into some specific areas or comparing it with other theories. To this group belongs an attempt to apply Kalecki's theory to the international division of labour among the CMEA countries (see J. Osiatyński, 'International Division of Labour and the Growth of National Income and Consumption in the System of Socialist Countries', *Ekonomista*, 62/4, 1969 (in Polish)), and a comparison of Kalecki's theory of growth with that of the Neoclassical Economics (see A. Chilosi, 'The Theory of Growth of a Socialist Economy of M. Kalecki', *Economics of Planning*, 11/3, 1971; see also A. Chilosi, S. Gómułka, 'Technological Conditions for Balanced Growth: A Criticism and Restatement', *Journal of Economic Theory*, 9/5, 1974).

The factor which limited the influence of Kalecki's Growth School was the attitude of the Communist Party and government authorities which well remembered Kalecki's unyielding and principled position in the Planning Commission and especially his 'indisposition' to persons highly placed in the Polish power-structure, in the course of the debate on the 1966–70 Plan (see *Collected Works*, vol. iii, pp. 419–27). Nevertheless, Kalecki's theory soon became incorporated in many Polish textbooks on the political economy of socialism (see e.g. M. Pohorille (ed.), *Political Economy of Socialism*, Warsaw, PWN, 1968; M. Nasiłowski (ed.), *Political Economy of Socialism*, Warsaw, KiW, 1972, 1974, 1975; J. Górski *et al.*, *Political Economy: A Popular Outline*, 4th edn., Warsaw, KiW, 1967 (all in Polish); for foreign popularizations, see e.g. M. Agdasi, 'The Main Features of Kalecki's Model of Growth of a Socialist Economy', *Planovo stopanstvo*, 23/4, 1968, in Bulgarian; G. R. Feiwel, 'Growth Determinants, Processes and Barriers in a Socialist Economy', *Keio Economic Studies*, 7/1, 1970). Even in the years 1968–73, when Kalecki's theory was sharply criticized, it maintained a prominent position in the books written or edited by some of his ardent critics. This widespread and possibly unrivalled 'textbook' success of Kalecki's theory contributed probably as much to its propagation as the work of the Kalecki Growth School.

Among early Polish responses there was a certain critical reaction, not so much to the *Introduction* itself as to its equation for economic growth which Kalecki had already advanced in his 1955–6 paper and used in his work on the Polish Perspective Plan. This line of criticism deserves closer examination since, as it will be seen, it was widely used and vulgarized in attacks on Kalecki's theory after March 1968.

In Kalecki's basic equation for economic growth the link between the increase in national income, on the one hand, and the changes in employment and the productivity of labour working on particular generations of plant and equipment, on the other hand, does not appear explicitly. This omission made Józef Pajestka consider Kalecki's model a 'single-factor, investment model of economic growth' (see J. Pajestka, *Employment, Investment and Economic Growth*, Warsaw, PWE, 1961, pp. 33–4 (in Polish)). However, in his book Pajestka first removes from Kalecki's basic equation those coefficients which determine the level of income in the already existing generations of equipment, because of either 'the great difficulty of their econometric testing', or, 'the impossibility to assume . . . that production growth attributed to these factors is some function of the volume of output', which implies 'serious problems in the interpretation of the *a* and *u* coefficients' (ibid., p. 33). Having thus removed the non-investment growth factors from Kalecki's model Pajestka finds its main shortcoming in this that 'production growth is determined by one factor only—investment' (ibid., p. 34).

Does Kalecki's model indeed fail to take account of labour as a growth factor? In the first formulations of Kalecki's model, available supply of labour enters as a limiting factor:

A rate of growth of investment that is faster than that of national income leads to a faster rate of economic growth. This strategy is feasible provided that some reserve of labour is available. But after it has been exhausted, the rate of growth is bound to fall

back to a level appropriate to the current balance in the labour market. (*Collected Works of Michał Kalecki*, vol. iii, pp. 135–6.)

In the *Introduction* Kalecki revised his approach and used two equations to determine the rate of growth of national income. In addition to the earlier equation (slightly modified to take into account changes in circulating capital) there now appears a second equation, defining the rate of growth as a function of growth of labour productivity α and of growth of employment β, or, somewhat simplified, in the form $r = \alpha + \beta$. The interrelation between the two Kalecki sees as follows:

Thus, the rate of growth of national income *r* is determined jointly by α, which depends upon technical progress, and β (which depends upon the natural rate of growth of the labour force). On the other hand, given the parameters *m*, *k*, *u*, and *a*, the rate of growth *r* determines the constant share of productive accumulation, *i*, in the national income, which is necessary in order to sustain it, on the basis of the equation

$$r = (1/k)\,i - (m/k)(a - u) \qquad [1]$$

[p. 28, this volume]

Thus, rearranging we get:

$$\left.\begin{array}{l} r = \alpha + \beta \\ i = rk + m(a - u)/k \end{array}\right\} \qquad [2]$$

The first of these equations defines the rate of growth *r* on the basis of labour supply and productivity growth, while the second defines the share of productive accumulation in national income necessary to achieve this *r*.

The original form of equation [1] facilitates a direct analysis of the effects on the time-path of national income and consumption of raising the rate of economic growth through the elimination of unemployment and through accelerating the growth of productivity by mechanization. Since the *Introduction* focuses mainly on these problems, Kalecki used equation [1] rather than its rearranged form in the system of equations [2]. However, since [2] is only a formal representation of the quotation from Kalecki cited above, the assertion that his model is 'a single-factor investment model of economic growth', which fails to take into account labour as a factor of production, is unfounded.

Research on the growth theory in a socialist economy flourished in Poland from the mid-1950s to the late 1960s. Kalecki's theory was only one among many. At least three other approaches can be distinguished by their methodology and scope. These were the aggregate, the multi-sector, and the historical-descriptive models of growth (see C. Józefiak, 'Problems of Economic Growth', in 'The Condition and Tasks of Economics', *Ekonomista*, 74/6, 1981, p. 1144 (in Polish)). The aggregate growth models relied on aggregate production functions (see e.g. J. Pajestka, *Employment, Investment and Economic Growth*). The multisector models partly originated from Marx's schemes of reproduction and modern input–output analysis (see e.g. Oscar Lange, *Theory of Reproduction and Accumulation*, Warsaw, PWN, 1969), and partly (in later years) from J. von Neumann and similar dynamic equilibrium models (see J. Łoś, 'Mathematical Theory of von Neumann Economic Models: Report on Recent Results', *Colloquium Mathematicum*, 40/2, 1979). Finally, the historical-descriptive models of growth were rooted in extensive empirical investigation (see S. Kurowski, *The Historical Process of Economic Growth*, Warsaw, PWN, 1963 (in Polish)). This fruitful period was broken off at the end of the 1960s. (S. Kurowski's study was already a target for non-scientific accusations shortly after its publication.) In 1968 Kalecki's theory came under an uninhibited wave of attacks, which also spread to other fields of research.

The wave of criticism in 1968–73

The root of economic strains, and the consequent political tensions which culminated in the events of 1968 and 1970, was the abandonment at the start of the 1960s of attempts to carry out fundamental economic reforms leading to greater autonomy of enterprises and developing workers' self-management. This manifested itself in the change of political climate around the Economic Council, followed by the termination of its work in 1963, as well as the neutralization of the workers' councils a few years earlier.

On the face of it, these circumstances might have strengthened Kalecki's position. At the time he attached possibly greater importance to limiting the arbitrariness of economic decision-making by the central authorities, and to the creation for them of conditions for rational choice, than to fundamental systemic changes in economic planning and management. In reality, however, the reverse was the case. He was defeated over the methodology of constructing the 1961–75 Polish Perspective Plan and its main targets, and forced to resign from his job in the Planning Commission in 1964 (*Collected Works*, vol. iii, p. 398).

Nevertheless, an important achievement of Kalecki and his team working on the perspective plan consisted in providing premisses for non-arbitrary decisions to be taken by the central planner on what, how, and for whom to produce. Kalecki's point of reference was the desire to increase not every output, but that destined to meet some well-defined consumer needs (see ibid., pp. 393–8). Among other factors, this

constituted the main strength of Kalecki and his associates in the Planning Commission, forcing their opponents to substantiate their counter-propositions in a similar manner.

The team which then gathered around Kalecki at the Main School of Planning and Statistics continued to develop the theoretical premisses of macro-economic decision-making on the general proportions of production and the rate of economic growth, which were first set out in Kalecki's *Introduction*. Attempts were made to create rational premisses for these decisions from the point of view of material balances, the foreign trade balance, technical and organizational barriers to growth, and especially the dynamics of consumption in the short and long run.

The social tension and student protests in March 1968 were the result of many factors, including non-economic ones. From the beginning of the 1960s dissatisfaction and frustration were expressed about methods and policies of the authorities towards culture and scientific research. Opposition towards the authoritarian way in which W. Gomułka and his associates governed, emerged in the ruling Party apparatus itself. At the same time, in the government and the Party structures there was a revival of demands to 'cleanse' the Party of 'alien elements'. In these circles, an aggressive 'anti-Zionist' campaign started in the second half of 1967. Without entering into an analysis of these various political factors and tendencies (see e.g. N. Davis, *God's Playground: A History of Poland*, 2nd edn., Oxford, Clarendon Press, 1982, pp. 589–91), it should be noted that neither Kalecki nor any of his associates at the Main School of Planning and Statistics were directly involved in these feuds and factional antagonisms.

The campaign which aimed at breaking up centres of independent economic thought and eliminating their leading representatives was initiated by a conference organized in early May of 1968 by the CSP (Central Party School) at the PUWP's Central Committee (the authorized contributions of its participants were published in a volume 'The Situation in the Political Economy of Socialism', in a series *Materiały i Dyskusje*, CSP, KC PZPR, no. 1, Warsaw, 1968 (in Polish)).

In a paper introducing the discussion Kalecki's model was accused of being 'a twin copy of the Harrod–Domar model'. Like these two authors, Kalecki was found to be 'confined by capital fetishism, ignoring the elementary fact that, despite appearances, the fundamental factor of production is not capital but the human being, the direct creator of material goods' (ibid., p. 23). His model was also criticized for an 'astructural character' (p. 24).

Another participant advanced the thesis that after 1956 a number of Polish theoretical economists:

in full awareness and premeditation undertook efforts to obliterate the difference between bourgeois and Marxist economics. . . . Models were created with a high degree of formal theoretical precision, that were equally applicable to capitalism as to socialism, which must bring much comfort to our ideological opponents. This comment applies above all to theory of growth in a the socialist economy. . . . The theory of growth as published by some of our theoreticians fulfils neither a productive, nor ideological function. If it is possible to detect any ideological function in it, it is probably . . . to soften up socialism' (pp. 44–5).

Another participant asked:

Can we consider without qualification as the top achievement of the Marxist-Leninist political economy of socialism, and an example of Marxist analysis, the theory of growth in a socialist economy, which stems from Kalecki's concepts and which has during the last few years been the most fashionable current in Polish economics, penetrating even into economic textbooks?

And he answered:

I do not think that the answer could be in the positive. The fashionable theory of growth in a socialist economy, as developed by M. Kalecki, K. Łaski, and their followers gives ground to a number of critical reservations concerning its sources of inspiration, methodological premisses, relevance to the actual process of growth and development of the socialist economy, etc. . . . We may doubt whether this theory of growth, as well as a large part of the theory of functioning of a socialist economy, can be considered to represent a creative development of Marxism in economics. There is no doubt, however, that uncritical identification of the ideas advanced by Kalecki, Brus, or Łaski with creative development of Marxism was wrong and has lead to significant damage (p. 56).

The participants of this conference planned to organize future meetings of this type, which 'would allow us to reveal and critically examine individual erroneous concepts in specific fields of political economy, indicate neglected problems requiring concentrated research efforts, and provide an opportunity to draw up a constructive programme of economic research' (p. 52). This resolution gives the context of the meeting of the Executive Board of the Polish Economic Society where similar ideas were put forward (see J. Pajestka 'At a New Stage of Progress', *Życie Gospodarcze*, 23/22, 1968 (in Polish)). This was followed by a conference at the Main School of Planning and Statistics where Kalecki and many of his associates taught and did research.

The latter conference organized on 17–18 March 1968 by the Rector and the School's Party Executive Committee dealt with 'The Main Problems of the Political Economy and Teaching It'. The discussion was started by presentation of four papers (see Dymitr Sokołow, 'Problems of Political Economy and its Development in People's Poland', a toned-down version of which appeared in *Życie Gospodarcze*, 23/25–6, 1968; see also his 'Political Economy', *Trybuna Ludu*, 21/170–1, 1968; Janusz Górski, 'Problems in the Theory of Economic Growth under Socialist Economy', *Życie Gospodarcze*, 23/27, 1968; Henryk Chołaj, 'Comments on the Agrarian Theory', SGPiS, 1968, mimeo.; Bronisław Minc and Ryszard Cheliński, 'Political Economy of Socialism: Theoretical Problems of a Lecture Course', SGPiS, 1968, mimeo. (all in Polish)). The first two papers were devoted specifically to Kalecki's theory of growth. Both implicitly elaborated upon its critical assessment given earlier by the branch executive board of the Polish United Workers' Party:

The Chair [of Political Economy] was concerned with a theory of economic growth which was highly abstract and formalized. This high degree of abstraction had a negative impact on the teaching process, causing students to ignore or misunderstand the phenomena which actually took place in our economy. Without undermining the advantages of Professor Kalecki's theory, the Executive Board of the Party organization considers that in this Chair there prevails an atmosphere of worship around this theory and Professor Kalecki himself. (Report of the PUWP's Executive Board at the Faculty of Foreign Trade of the Main School of Planning and Statistics to a general Party meeting on 9 May 1968, pp. 10–11 (in Polish); a copy of the report is in Kalecki's papers.)

Without distinguishing between Kalecki's theory of economic dynamics in a capitalist system and his theory of growth in a socialist economy, Sokołow observed that the latter methodologically drew from the former, especially in its formulations. This, in turn, he criticized for failing to allow for long-run supply constraints on production in a capitalist economy. He also reproached Kalecki for the 'investment nature' of his theory of socialist economic growth. But he mainly found fault with Kalecki's closest associates who, instead of 'winning over to Marxism this scholar brought up in the progressive wing of bourgeois economic thought' had 'capitulated in the face of a stronger scientific personality'.

A violent criticism of Kalecki's theory was next advanced by Janusz Górski. He concentrated on Kalecki's theory of growth in a socialist economy, taking as the butt of his attacks Łaski's book, *An Outline of a Theory of Socialist Reproduction*. Not long before, in a review of this book, he praised it for its methodology and originality, as well as skilful and bold use of modern research methods, and he wrote that it constituted 'a good theoretical generalization of many economic phenomena, as well as the basis for many practical decisions' (J. Górski, 'The Theory of Growth in a Socialist Economy', *Polityka*, 10/8, 1966 (in Polish)). Now Górski criticized Łaski and Kalecki for failing to appreciate the Marxist origins of contemporary theories of growth. Kalecki in particular was accused of 'not indicating as well the relationship between his own intellectual construction with those of Harrod and Domar, formulated in 1947–50, a few years earlier therefore than Kalecki's growth formula'.

This latter accusation was strange in so far as, in 1964, in Zakopane, at a conference of the Political Economy Chairs, Kalecki stated outright that the growth equation which he used for the socialist system was an extension of the Domar equation. He also indicated the similarities and differences between his formulation of growth factors in a capitalist economy, and those of Harrod and Domar, as well as the Marxian schemes of reproduction. Ironically, this comment was made by Kalecki in the course of the discussion on a paper by Górski himself. (See *Collected Works*, vol. ii, p. 559). In 1971, in the above-mentioned review of the *Introduction*, Roy Harrod also pointed out that Kalecki modified the Harrod–Domar equation without reference to the original formulation; Branko Horvat, in his *Economic Journal* review of Kalecki's *Selected Essays on the Economic Growth of the Socialist and the Mixed Economy* notes that 'what Kalecki did was to dynamize the familiar Harrod–Domar model by introducing coefficients *a* and *u*', and that bearing one institutional assumption Kalecki's model 'is a perfectly general piece of analysis with nothing particularly socialist about it' (p. 256). (For Kalecki's view on this point, see p. 260 below.)

Furthermore, Górski criticized Kalecki's theory for its alleged excessive formalism, lack of realism and potential for empirical verification and practical application, a declining marginal utility of its further development, succumbing to bourgeois economics' influence, lack of analysis of the social factors and conditions of growth in a socialist economy, and detachment from the theory of functioning of a socialist economy. (This last point had been made earlier by Włodzimierz Brus—see e.g. his 'Growth and the Model', *Życie Gospodarcze*, 14/2, 1959 (in Polish)—and following him, by other economists concerned with these matters. The irony was that precisely those economists were now charged with the responsibility for the inadequate integration of socialist growth theory with the theory of its functioning.)

In conclusion Górski wrote:

> A complete theory of growth of a socialist economy, like Marx's theory of growth, cannot limit itself to a formal and ahistorical analysis of general growth functions presented exclusively from the point of view of an investment model of growth. . . . This kind of merely mechanistic argument leads in fact to a lack of appreciation of the fundamental growth factor—human labour. ('Problems', pp. 17 and 19.)

At the end of his paper, Górski suggested that the social determinants of labour productivity under socialism should be explained in a general theory of growth. Empirical research on a number of topics should be undertaken to test the abstract hypotheses of the theory, and the university curriculum in economics in Poland should be rearranged in order to enable such research to proceed.

Kalecki firmly rejected this critique. His contribution to the debate, which he made on the first day of the conference, follows in Annex 2.

ANNEX 2

Contribution to the Debate on 'The Main Problems of Political Economy and Teaching It'[1]

Due to poor health I am unable to participate in the whole debate. I shall therefore limit myself to evaluation of the presented papers. These would draw the attention of a sociologist or a historian; being an economist, they are of lesser interest to me. In large part they are verbose, vague, and their economic reasoning is of low standard. Specific criticism is unfortunately concerned with 'framing' myself, Włodzimierz Brus, and Jerzy Tepicht, and it is launched by 'promising young men' who have not lived up to the hopes that had been invested in them. Some restraint has still been shown for me, but in the case of Brus and Tepicht their ideas have been rendered truly devilish. I shall not deal with empty verbosity, but restrict myself to specific charges. I shall first examine the criticism of my theory and then pass to the demonization of Brus and Tepicht.

The argument put forward in Sokołow's paper does not hold together. Growth of a socialist economy is linked here to effective demand, which makes no sense. He accuses me of an investment formula of growth, but fails to mention the coefficient *u*, which represents non-investment growth factors. Górski maintains that my model is a two-factor one since 'elements of a two-factor construction show through in the way production methods are selected, which influences in turn the value of the capital–output ratio'. It is unclear what this is supposed to mean.

The proper object of Sokołow's critique is my theory of dynamics of the capitalist economy. My demand-constrained model Sokołow contrasts with his own supply-constrained model of long-term development of this economy. The argument which we find on pages 7 and 8 of Górski's paper is indeed a perfect critique of Sokołow's model. I do not aspire to this kind of Marxism, which in fact obscures the contradictions of monopoly capitalism. The essence of Marxism consists of elucidating these contradictions. From 1933 to 1968 I worked on explaining them. In 1954

[1] Published following handwritten notes which survived in Kalecki's files. At the time of the conference Kalecki was recovering from diabetes.

I showed how they were naturally resolved in a socialist economy. I did not close my eyes to the way in which government expenditure, especially on armaments, overcomes contradictions under capitalism, and I showed that they are in no way removed automatically, but as a result of the struggle between monopolies and their representatives. This is the subject which I investigate in my little book *The Last Phase in the Transformation of Capitalism*.[2]

The analogy between my theory and those of Keynes and Domar, made in Sokołow's paper, is wrong. Keynes failed to make a distinction between investment and investment decisions; he also did not show that capitalists' profits, rather than some nebulous propensity to save, are the mainspring of economic decisions.

As for monopoly on economic theory, I know nothing about cases of muting criticism in the Chair [of Political Economy] in which I worked together with Sokołow. I was a member of the editorial board of *Ekonomista*. I do not recall a single case of Sokołow writing for *Ekonomista* something which was rejected. Did Bronisław Minc have any problems in criticizing Brus? He attacked him with great zeal and no one tried to stop him. When the Faculty Board deliberated on the creation of a professorship specializing in business research, I voted for it and for giving Sokołow the Chair.

I now turn to Górski's paper. On pp. 4, 6, and 8 he points out that Łaski and myself failed to acknowledge the origins of my growth formula. First of all, the formula is so straightforward that I do not consider it to be a new discovery on whose pedigree it is necessary to expatiate. It is simply an identity expressing the balance of the increase in productive capacity. I introduce this formula on one and a half pages in a book 120 pp. long. It is merely a canvas for subsequent analysis, which is completely different from either reproduction schemes or Harrod–Domar models. The latter are concerned with the capitalist system and are therefore supply and demand models, while my approach is only supply analysis. Moreover, in my theory investment and capital–output ratios are expressed in gross terms. But even in the

[2] The book was published in English by Monthly Review Press, New York/London, 1972.

field of supply and demand models of the Harrod–Domar type, I would not need to cite them for the reasons put forward by Professor Austin Robinson in an article published in the *Economic Journal* of Mar. 1947.

The favourable evaluation of the Cobb–Douglas function to me seems unjustified. As a static curve of production, it is not needed; if it is used to study changes which take place over time, then it can neither serve for separating the effects of substitution from those of technical progress, nor be used for extrapolation. In fact, in advocating the use of the Cobb–Douglas function one proposes to integrate into Marxist analysis the worst type of economic instruments.[3]

J. Górski maintains that we have had enough of formal models and the time has come for our theory to include social factors. This seems to be in contradiction with his suggestion to promote research on the Cobb–Douglas function.

Is the time of the aggregate growth theories over? In accordance with what I have written, I think that the theory of growth of a socialist economy will be of broad scope and complexity. What I have put forward up to now is tentative and incomplete. There is a suggestion that the argument which concludes that an acceleration in economic growth requires an increase in the share of productive accumulation in national income is anachronistic. I consider this suggestion to be erroneous. In fact it is precisely this 'formalized' argument that proves the assertion which Górski advances without any substantiation on p. 20 of his paper.

However, his assumption about increasing labour productivity and the coefficient u, which is put forward later on, is entirely arbitrary. Such an assumption means increasing labour produc-

[3] This critique of the Cobb–Douglas function seems perhaps too harsh. Kalecki also made use of a certain function of production, which he called the 'production curve'. Due to specific features of his theoretical analysis, he did not need to specify this function; he only needed that it postulated constant returns to scale. There are many production functions which meet this condition, including that of Cobb–Douglas. The difficulty of empirical separation of substitution from technical progress applies to all production curves, including that of Kalecki. In practice one can only observe the actually selected points *ex post facto*, and there is no way of precisely determining the position of points which have coexisted at a given time but have not been selected (indeed, empirical separation of the effect of 'pure' technical progress from the substitution effect has been proved to be impossible).

tivity on paper only. If this productivity can be increased, why has this not been done before? It was precisely because I exposed such voluntarism, manifested in raising plan targets on paper, that I had to leave the Planning Commission. In the argument put forward on p. 20 of Górski's paper, no account is taken of foreign trade. Allowing for this factor could fundamentally alter his conclusions.

Is my theory detached from real life? If one is not to be arbitrary, then assumptions about the growth of labour productivity must be based on the development of science and education. That too requires outlay. The results of this outlay should be examined. Such an analysis ought to constitute an integral part of the theory of growth. However, it would make the formal model more complex. In my opinion we must first improve the existing model.

This abrupt eruption of criticism is strange. Górski co-authored the book *Political Economy: A Popular Outline*. The book broadly popularized my theories, which have thus 'reached the masses'. In his review of Łaski's book, Górski wrote among other things: 'Polish economic science has during the last few years made an important contribution to the development of growth theory in a socialist economy. These achievements must above all be attributed to the works of Professor Kalecki and the team of his close associates.' Well, voluntary judgements are much more effective when it comes to changing one's opinion than in raising labour productivity, also in scientific research.

There are two reasons why I can act as a referee for Włodzimierz Brus's scientific contribution. First of all, I have never considered changes in the economic model as a panacea for all problems. Secondly, I did not share all of Professor Brus's opinions, and I took part in many conferences and debates which gave birth to his book.

The extreme decentralization is characterized by three main features: (i) enterprises set their own prices for goods they produce, which in practice implies monopolistic competition; (ii) the wage bill and the profits are not set for an enterprise in advance; and (iii) complete decentralization of investment is allowed (only the total outlay on productive investment may be limited, while each enterprise finances investment out of its own funds or contracts credits which it must repay with interest).

The model proposed by Brus has none of these features and does not vary much from official policy in respect of them. Moreover, in its abstract form this model features less elements of the command-type economy than the present practice, but it makes provisions for replacing incentives with directives should the need arise. On the other hand, the declared principles of government policy rather point towards decentralization.

Therefore I see no fundamental difference between the ideas of Brus and the principles of official policy. Thus, there is no reason for making Brus into a demon of decentralization. In economic writings one can find much more extreme ideas than those of Brus and yet they are not found to be so outrageous.

The same is true of Jerzy Tepicht. He is accused of not going far enough in his critique of the concept of collectivization during the Six-Year Plan. This accusation is unfounded as no one had undertaken a more trenchant criticism than Tepicht. Indeed, had he wanted to go further, he would have to cite what happened at that time in the Soviet Union, Bulgaria, Romania, and so forth, since what was done in Poland did not fundamentally differ from the experience of these countries. What then would Minc say, who in his paper criticizes Mieczysław Mieszczankowski for considering the collectivization in the USSR and in other socialist countries as based on the concepts of Stalin and Larin, and contrary to the principles of Marxism-Leninism?

At present Tepicht favours a combination of a putting-out system and agricultural associations. These ideas conform to government policy both in the short and in the long run. They also conform to the ideas of Henryk Chołaj.

It is only recently that there has emerged the problem of taking over declining private farms by state farms—an issue which it is to be hoped will be handled with caution. The ultimate pattern of the agrarian system seems as yet undecided. Chołaj is worried about the indifference of peasants who work in putting-out schemes. He probably would not therefore want to force them to associate in co-operatives or to surrender their farms to the state. We do not know, however, when the farmers will themselves come to the conclusion that they want to turn their farms into co-operatives or state farms. Criticizing Tepicht for offering no comments on the future prospects is therefore out of place.

The 'devilish' nature of Brus's and Tepicht's ideas is nothing but a myth.

I have said what I found to be most important about the papers and what I could deal with in this already too lengthy speech. You will draw from it such conclusions as you see fit.

The organizational consequences of this action appeared very quickly in the breaking up of the circle of economists which Kalecki had gathered around himself. Kazimierz Łaski, Ignacy Sachs, and a few of their and Kalecki's close associates and pupils were dismissed from the Main School of Planning and Statistics. At the beginning of Oct. 1968 Kalecki submitted his resignation to the Minister of Learning and Higher Education, Professor Henryk Jabłoński:

After considering the events which took place at the Main School of Planning and Statistics in the academic year 1967/8, I have decided to leave the school in the current academic year, and not in the next one, after the [retirement] age of seventy.

I therefore ask to be discharged from my post of full professor at the Main School of Planning and Statistics, starting on 30 September 1968. (A copy of the letter is in Kalecki's files.)

The resignation was accepted.

Earlier, on 12 Apr. 1968, the Scientific Secretary of the Polish Academy of Sciences accepted Kalecki's resignation from the chairmanship of the Research Committee on Social Issues of People's Poland (for more on these activities of Kalecki, see pp. 338 and 342, this volume). Within a short time Kalecki was removed from the scientific board of the Research Institute for Developing Countries (28 Oct. 1968), the Editorial Board of the *Gospodarka Planowa* (15 Mar. 1969), from the Committee for Science and Technology (30 June 1969), and from the Editorial Board of *Inwestycje i Budownictwo* monthly (30 Jan. 1970).

In the next few years the wave of criticism practically died down, but at the turn of 1973 it reappeared. At that time it was stimulated by exceptionally good economic performance by the Polish economy in 1971 and 1972, with industrial and agricultural output, investment, foreign trade, and personal incomes substantially exceeding plan targets. The abundance of those two years and a simultaneous acceleration of investment and consumption growth seemed to confirm the criticism that Kalecki's 'investment theory' did not take sufficient account of the critical role of the human factor in the growth processes (see e.g. W. Iskra, 'The Basic Factor of Development', *Życie Gospodarcze*, 27/43, 1972 (in Polish)).

Furthermore, this success gave rise at that time to a phenomenon that Kalecki had always warned against: years of exceptionally good harvests and good performances in other spheres of economic activity which were caused by a coincidence of favourable but fortuitous circumstances rather than long-term development trends, inspired an impetuous wave of 'hurrah-optimism' in setting future development targets. For months the daily press, as well as *Życie Gospodarcze* and *Nowe Drogi* (the main Polish economic weekly and the Party's main theoretical monthly respectively) conducted a discussion as to whether to project an annual economic growth rate for the next twenty years of 10% (or at a minimum 7%). 'Summing up our conclusions', wrote one of the leaders of these projects, 'it must be repeated once more that we should not be reticent in envisioning Poland's future. Let us set for ourselves more daring tasks. Let intentions be the measure of our potential. Intentions should run ahead of the potential. This is what mobilizes us. A young, dynamic Polish generation must face difficult but feasible tasks. Tasks which will give it a chance. The favourable conditions are there.' (Z. Rurarz, 'Premisses for Accelerating the Country's Development', *Nowe Drogi*, 26/10, 1972; see also by the same author 'A Half Percent More', *Życie Gospodarcze*, 29/12, 1974 (both in Polish).)

Against this background a critique of the foundations of Kalecki's theory was put forward. Referring to Pajestka's popular view that investment also stimulates consumption in the short run, it was argued that at a certain stage of development of a socialist economy the contradiction between investment and current consumption disappears altogether. Therefore, Kalecki's alleged mistake consisted in failing to take into account the fact that 'investment pays for itself'; once this is realized, argued the critic, it is possible to explain the simultaneous growth of investment and consumption, and understand the illusory nature of the contradiction emphasized by Kalecki's theory. (See Andrzej Krawczewski, 'The Errors of Theory and the Corrections of Practice', *Życie Gospodarcze*, 29/49, 1972, and 'Models and History', *Życie Gospodarcze*, 30/46, 1973, by the same author. Similar criticism of Kalecki's theory was advanced by W. Iskra, 'The Theory of Economic Growth in Economic Textbooks', *Nowe Drogi*, 26/12, 1972, pp. 88–9. Krawczewski's argument, which was based on a mechanical transposition to the socialist economy of the relations between investment and consumption in a developed capitalist economy, already discussed by Kalecki in his pre-war publications, was criticized by M. Nasiłowski, 'On Alleged Errors in the Theory of Socialist Accumulation', *Życie Gospodarcze*, 30/2, 1973, and J. Osiatyński, 'The Contradictions between Investment and Consumption', *Życie Gospodarcze*, 31/13, 1974, (all in Polish)).

The criticism, advanced by Krawczewski, Rurarz, and others indicates that the direction of attacks upon Kalecki's theory had now changed; whereas in 1968 he was held responsible for overinvestment in the Polish economy, conjuring up a 'Moloch of Investment', now he was accused of excessive caution in this respect. As readers will find themselves, neither the *Introduction* nor his other writings substantiates any of these accusations.

In concluding a more detailed account of the criticism of Kalecki's theory from 1968 to 1973, the present commentator found this criticism to have been:

> prearranged, inspired by extra-scientific motives, and aimed at discrediting the scholarly authority of Kalecki himself and his closest associates. Having achieved its immediate goal, the criticism rapidly faded away. This activity also had long-term adverse effects in that it broke the continuity of theoretical analysis, and checked the development of the scholarly disciplines affected by these purges, including the theory of growth in a socialist economy. (J. Osiatyński, *Michał Kalecki on a Socialist Economy*, p. 116; see also G. R. Feiwell, *The Intellectual Capital of Michał Kalecki*, Knoxville, University of Tennessee Press, 1975, pp. 447–55.)

Further debate on Kalecki's model

In the first half of the 1970s a number of attempts were made to develop Kalecki's growth theory or to construct a new one that would rely on a different research methodology.

Wiesław Iskra tried repeatedly to increase the number of growth factors and arrange them differently from the way in which they operate in Kalecki's model. He constructed a so-called 'energy and raw materials' economic growth formula, but it was shown to have been based on a circular argument (see W. Iskra, 'Raw Materials and Energy Factors', *Życie Gospodarcze*, 30/13, 1973, and C. Józefiak, 'Raw materials—Factors and Theory', *Życie Gospodarcze*, 30/26, 1973 (both in Polish)). A 'labour growth model', announced by Iskra at the end of the 1960s, which was to oust and supersede Kalecki's 'investment model', turned out to be little different from the latter, while the changes introduced in it were widely criticized (see W. Iskra, *The Human Factor in Economic Development of the Socialist Countries*, Warsaw, PWE, 1974 and M. Nasiłowski, 'The Use of Kalecki's Formula in the Analysis of Economic Growth', *Ekonomista*, 68/5, 1975, p. 1031 (both in Polish)).

The need to incorporate a limited supply of raw materials into the theory of economic growth, and thereby to create an operative theory of economic calculation, was postulated by Marian Ostrowski and Zdzisław Sadowski (see their 'Comments on the Role of the Raw Materials Bottleneck in Economic Development', in J. Lewandowski and W. Siwiński (eds.), *Growth and Functioning of a Socialist Economy*, Warsaw, PWE, 1978 (in Polish)).

Kazimierz Secomski, too, argued in favour of expanding Kalecki's classical model. He suggested that its growth equation should include not only the growth of material production, but the increase in social, cultural, and other non-material services. He also proposed to allow for structural and qualitative development affecting economic growth. In addition to investment in material production, he suggested taking into account non-productive investment. Moreover, he wanted the impact of non-investment factors of growth to be made more specific (through modernization of the economic infrastructure, stimulation of innovations, international division of labour and the economic integration of the CMEA countries, improvements in the system of economic organization and planning, etc.). He also argued for a partial optimization approach to the above factors. (See K. Secomski, *Elements of Political Economy*, Warsaw, PWE, 1972; 'Modern Socio-Economic Development and the Classic Model of Economic Growth', *Ekonomista*, 68/5, 1975; *Socio-Economic Policy: an Outline of Theory*, Warsaw, PWE, 1978 (all in Polish).) However, carrying out these extensions encountered several difficulties, mainly connected with measuring the intensity of the effects of individual factors, let alone their optimization. Similar problems arise in practice in attempting to measure the contribution of non-productive investment to economic growth.

Another approach to the theory of growth of a socialist economy was tried by Józef Pajestka. He argued for the rejection of traditional growth theory based on the analysis of particular growth factors, in favour of a systems analysis of models whose aggregate behaviour would be determined by the interactions of their parts. (See his *Determinants of Progress: The Factors and Interrelationships of Socio-Economic Development*, Warsaw, PWE, 1975; and 'On the Margins of the "Theory of Economic Growth"', *Życie Gospodarcze*, 33/1, 1976, both in Polish.) Pajestka's approach belongs to the school of thought which started in the 1960s in the United States, and whose concept of system dynamics was outlined in 1970 by J. Forrester within the 'Project on the Predicament of Mankind', and was later used for the elaboration of the first report of The Club of Rome (see D. L. Meadows *et al.*, *The Limits to Growth*, New York, Universe Books, 1972. For latter developments in system dynamics, see K. E. Boudling, *Ecodynamics*, Beverly Hills/London, Sage Publications, 1978.)

In relation to Kalecki's theory, Pajestka maintained his earlier criticism that it was too narrowly investment-based. In addition, he accused it of excessive formalism, and a failure to take into account social factors in general, and the 'human factor' in particular (see *The Determinants of Progress*, pp. 29–32, 66–7, 257 ff.; for a criticism of this allegation, see W. Herer and W. Sadowski, 'The Theory of Growth in a Socialist

Economy Faces New Problems', *Zycie Gospodarcze*, 33/1, 1976; see also Pajestka's rejoinder in the same issue of *Zycie Gospodarcze* (all in Polish)). In this context Pajestka writes:

Returning to our scheme of interrelated development, it should be pointed out that the effect of the distribution of income on economic growth cannot be understood in the sense that only that part of national income which is devoted to investment contributes to economic growth. The part allocated to consumption also contributes to it, especially, but not exclusively, through its influence on the human factor. In algebraic growth formulae based on investment as the main growth factor, the higher the rate of investment, the faster is the rate of economic growth. . . . Fundamental characteristic features [of the classic model of the interrelationships in the development process] attribute decisive significance to the link between investment and the growth of production, treating consumption as a resultant effect, which comes out beyond the development model. . . . It would be more appropriate to state that *increasing the satisfaction of human needs contributes to economic progress and is a necessary condition for it, rather than that it is a sufficient reason for it.* (*The Determinants of Progress*, pp. 66–8; italics by Pajestka.)

This appears to be a misrepresentation of Kalecki's theory in so far as consumption in Kalecki's model is not a 'resultant' variable, but one from the determination of which the process of planning alternative rates of growth of national income indeed begins. Nor is it true that Kalecki wholly neglected the feedback effects from increases in the standard of living on the growth of labour productivity, or the importance of what he himself called 'socialist awareness of society'. The main difference between Kalecki's and Pajestka's approaches can be reduced, simplifying somewhat, to differences in the objective functions that their respective theories postulate for a socialist economy.

In Kalecki's theory the objective function is the level and growth path through time of consumption over a given period. In effect, in his paper at the Second Conference of Polish Economists in 1956, and subsequently in his *Introduction*, Kalecki put forward consumption as the basic aim of economic activity under socialism, in place of economic growth, industrialization, and so on. This change in the objective function was reflected in the clear and unequivocal analytical division of national income into that part of it which is consumed, which was the purpose of economic activity, and that part which was accumulated, and thereby was the means to the realization of that purpose. Hence the importance which he attached to 'transitional processes' and the significance of his formalization of the choice of the rate of growth, in the form of the 'government decision curve'.

In many subsequent critiques of Kalecki's theory, there appeared a renewed concentration on the rate of economic growth itself, and even a certain fetishism of it. If we leave aside their verbal declarations, we find at the centre of their interest not the human being as the subject of history, nor even personal consumption as the purpose of economic activity, but the 'human factor' as the most important factor in economic growth. Consumption is obviously also important but, in these approaches, its importance is primarily in so far as it contributes to economic growth. 'Investment in human capital' is important not in itself but primarily because it increases the effectiveness of this most important growth factor, and so on. (J. Osiatyński, *Michał Kalecki on a Socialist Economy*, pp. 120–1.)

The economic strains of the second half of the 1970s, culminating in the Polish economic crisis of the 1980s, prompted Pajestka to revise his views on the relationship between investment and consumption. Presenting his own diagnosis of the causes of errors in the economic policy in the 1970s, he wrote:

A battle was also fought over the share-out [of national income] between the central authorities and the society, which we have previously described as a conflict between the development mission of the authorities and the consumption aspirations of the population. For a while it appeared as if both sides were winning: investment was rising rapidly, as well as earnings and various social benefits. Historical experience showed us that this was not so: both sides were losing, and the nation lost. (J. Pajestka, *The Polish Crisis of 1980–1981: Its Causes and Consequences*, Warsaw, KiW, 1981, p. 90 (in Polish).)

Another course of research inspired by Kalecki's theory is represented by studies aimed at a better integration of this theory with the analysis of the functioning of the socialist economy. This work was systematically pursued in Poland in the 1970s by C. Józefiak (see his articles 'The Conditions for Stimulating Non-investment Factors of Economic Growth', *Ekonomista*, 69/5, 1976, and 'Functioning and Growth', *Zycie Gospodarcze*, 34/27, 1977 (both in Polish); for another line of research in this field, stimulated by the works of J. von Neumann, R. F. Harrod, and M. Kalecki, see J. Kornai, *Growth, Shortage and Efficiency*, Oxford, Blackwell, 1982). Józefiak also undertook a pioneering attempt, in the literature of the socialist countries, to define the maximum permissible level of foreign debt for a centrally planned economy, using Kalecki's model (see C. Józefiak, 'The Profitability of Foreign Investment Credits', *Ekonomista*, 72/3, 1979 (in Polish)). Together with Jan Mujżel, he also put forward an interesting reinterpretation of Kalecki's concept of 'barriers' to economic growth (see their *Reproduction in a Socialist Economy*, Warsaw, PWE, 1974 (in Polish)).

Abroad, in the 1970s, Kalecki's theory was elaborated by many of his students and former associates. Kazimierz Łaski used Kalecki's model in a thorough examination of the applicability of neoclassical growth models and investment programming for the theory and practice of planning in a socialist economy (see K. Łaski, *The Rate of Growth and the Rate of Interest in the Socialist Economy*; see also his 'Les importations des capitaux et d'équipement et la croissance dans les pays socialistes', *Revue d'études comparatives est-ouest*, 10/4, 1979; 'Über das Wachstumstempo der Abteilung I und II', in *Socialismus, Geschichte und Wirtschaft: Festschrift für Eduard Marz*, Vienna, Springer-Verlag, 1973).

Stanisław Gómułka took up the problem of technical progress in Kalecki's model, disaggregating it in order to take into account not just the 'natural age' of particular vintages of productive equipment, but also their 'technological age' (see S. Gómułka, 'Inventive Activity, Diffusion, and Stages of Economic Growth', Arhus, *Monographs of the Institute of Economics*, 1971, no. 24; 'Do New Factories Embody Best Practice Technology? New Evidence', *Economic Journal*, 86/4, 1976; 'Growth and the Import of Technology: Poland 1971–1980', *Cambridge Journal of Economics*, 2, 1978; see also: S. Gómułka and J. D. Sylwestrowicz, 'Import-Led Growth: Theory and Estimation', in F. L. Altman, O. Kyn, H. J. Wagener (eds.), *On the Measurement of Factor Productivities: Theoretical Problems and Empirical Results*, Gottingen/Zürich, Vandenhoeck & Ruprecht, 1976). For a general appraisal of Kalecki's theory, see M. White, 'Kalecki's Theories of Economic Growth and "Development"', *Journal of Contemporary Asia* (Stockholm), 7/3, 1977. For examining the relevance of Kalecki's theory of growth in a socialist economy as seen from the perspective of the late 1980s, and mapping out directions for further research, see D. M. Nuti, 'Michał Kalecki's Contribution to the Theory and Practice of Socialist Planning', *Cambridge Journal of Economics*, 10, 1986, and J. Osiatyński, *Michał Kalecki on a Socialist Economy*, pp. 125–8.

The empirical testing of Kalecki's model

The first empirical verification of the model put forward in the *Introduction* was obviously in the confrontation between Kalecki's perspective plan and the actual economic outcome of the years 1961–75. There was a close coincidence between economic development as projected in that plan and actual performance, despite some quite fundamental changes in economic policies during the 1970s (see *Collected Works*, vol. iii, pp. 399–401). This seems to indicate that the model, when properly used, can serve as a practical instrument for economic planning and forecasting.

In the mid-1960s a number of attempts were made to test Kalecki's model not as a forecasting model, however, but *ex post facto*, using it to explain actual growth in the long term and the quantitative contributions of particular factors to the overall rate of economic growth. The 1960s also saw the rapid development of econometric and statistical studies of this kind. Most of them, in the West as well as in the centrally planned economies, used simplified production functions of the Cobb–Douglas kind. The first attempts to use Kalecki's model in this type of analysis were made in Czechoslovakia, where the model was used as an alternative to Cobb–Douglas and similar production functions which inspired many methodological and other reservations.

In generalizing his experience of perspective planning in his outline of growth theory, Kalecki integrated micro-economic elements of his model (for example productive investment in particular industries, the capital–output ratios in particular activities, the increase in different stocks and reserves, various non-investment improvements in efficiency) into overall economic aggregates. It therefore became necessary, in testing the model empirically, to disaggregate some of his general categories.

The Czech economists J. Goldman and J. Flek were primarily interested in isolating the effects of changes in the system of economic planning and management on the rate of economic growth. This enterprise was in part associated with attempts at economic reforms in Czechoslovakia at the time. Goldman and Flek disaggregated the coefficient u, which in Kalecki's model represents the effect of non-investment growth factors. They separated out the effects of this set of factors, more narrowly defined, as well as the influence of superfluous increase in stocks and reserves, and that of unspecified factors causing cyclical fluctuations in the volume of investment and output in a socialist economy. (See J. Goldman, 'Model hospodářského růstu za socialismu a kritérium efektivnosti soustavy plánovitého řizeni', *Planované Hospodářstvi*, 19/3, 1966; 'Economic Growth in Czechoslovakia: Experimental Application of Kalecki's Model to Czechoslovak Statistical Data', *Economics of Planning*, 6/2, 1966; see also J. Goldman, 'The System of Planning and Management and Economic Growth', *Zycie Gospodarcze*, 22/7, 1965 (in Polish).)

Another Czech economist went in a similar direction, disaggregating the coefficient of the increase in stocks and reserves. He distinguished in it the ratio of the increase in productive reserves to that of national income, u_1, and the ratio of unfinished investment to national income, u_2 (see V. Nachtigal, 'Modifikace základni rovnice v Kaleckého růstovém modelu socialistické ekonomiky rozlozenim koeficientu μ', *Politická Ekonomie*, 14/8, 1966). After introducing these modifications, Kalecki's formula was applied to the analysis of economic growth in Czechoslovakia in 1950–60 (Nachtigal) and 1950–65 (Goldman and Flek) respectively.

The results of these experiments were rather unsatisfactory. In the autumn of 1966, Kalecki's Socialist Growth Theory Seminar discussed the Goldman and Flek study. Various shortcomings were found in it, including those of linear regression techniques. Prior to this discussion, in his letter to J. Goldman, of 21 June 1966, Kalecki wrote:

Dear Goldman,

Now that my recovery has advanced considerably and I have managed to cope with the arrears resulting from my illness, I studied carefully your two papers: *Economic Growth in Czechoslovakia* and *The Kalecki's Model of Growth under Socialism.* I have no objections as to the latter; however, there are some points which are not clear to me in the former paper.

(i) I fail to understand at all how you pass from equation (1) to equation (2) on p. 8 of the English MS. To my mind you should have

$$r' = (1/m)(I/D) + u_1 + u_2 - a$$
$$u_1 + u_2 - a = 5.04 - 0.81t$$

while you equate $u_1 + u_2 - a$ with -0.8 which I cannot fathom. If as you assume $u_1 = 1.3\%$ and $a = 1\%$, it follows that

$$u_2 = 4.74 - 0.81t$$

(ii) This would be true if r were approximately equal to r' which, of course, is not the case, in particular because the actual trend is far from linear. Therefore, I think, the linear trend assumption must be used only for obtaining m. Thereafter u_2 may be represented as

$$u_2 = r - 0.48\ I/D - (1.3 - 1.0) = r - 0.48\ I/D - 0.3$$

and I believe that it is this series to which the economic analysis should apply. This analysis should show the reasons for changes in the utilization of equipment different from u_1, such as shortages of raw materials and labour, deterioration in the quality of production (if this is reflected in the statistics of national income), etc. In such analysis the problem of 'cyclical' changes may be considered (which you cover by the factor u_4).

(iii) I do not think that your factor u_3 is relevant to equation (1). Excessive increase in inventories or in the capital under construction does not affect the relation between r and I/D if I represents the value of the fixed assets coming into use in a given year. These factors will, however, affect negatively consumption given the rate of growth of the national income.

I discussed this subject with Brus and he agrees in general with my opinion.

Yours very sincerely

P S: I am leaving in ten days time for a health resort so that the letters arriving after that day will reach me with some delay.

(Unsigned manuscript of the letter is in Kalecki's files.)

These and similar problems of statistical nature encountered in first attempts of empirical testing of Kalecki's model discouraged further empirical studies. This can only be partly explained by the scepticism with which Kalecki's closest associates in the 1960s regarded the methodological validity of disaggregating the overall rate of economic growth into separate components. Among Kalecki's circle, as among the circle around Keynes in the 1930s, interest in constructing theoretical models was not strongly linked to attempts at their empirical testing. However, while in the 1930s it was Kalecki who tested statistically many of the Keynesian theory's propositions, the statistical verification of Kalecki's growth theory was left undeveloped in the 1960s. This lack of empirical testing, combined with the failure to explain fully the shortcomings of the pioneering Czechoslovak studies, rebounded on Kalecki's theory in 1968. Among the criticisms of it that were then advanced was one that 'The advocates of Professor Kalecki's model have not undertaken any empirical attempt to check it against data on the economy. . . . Such attempts were made in Czechoslovakia, albeit without much success. It should be made clear if the shortcomings of this verification were the outcome of inept analysis, or the unsuitability of the model itself for empirical testing' (J. Górski, 'Problems of the Theory of Growth', p. 23). Some time later, in the same wave of criticism, the very possibility of statistical testing of Kalecki's model was put into question.

At the same time the critics of Kalecki's 'one-sided, purely investment-based' approach advocated the analysis of the effects of various growth factors using the methodology of E. F. Denison (see his *The Sources of Economic Growth in the United States and the Alternatives before Us*, New York, Committee for Economic Development, 1962 and *Why the Rates of Growth Differ*, Washington, Brookings Institution, 1967; see also the debate in *Zycie Gospodarcze*, in 1969–70). But the results of such analyses were meagre compared to the hopes that were invested in them. It proved impossible to work out a method of measuring the factors in such a way as would not arouse serious methodological questions. This also gave rise to scepticism about the actual results obtained, which only contributed marginally to a knowledge of reality. (For a criticism of Denison's method and a defence of Kalecki's, see W. Herer and W. Sadowski, 'Capital Intensity and Technical and Organizational Progress', *Zycie Gospodarcze*, 27/9, 1970, and J. Osiatyński, 'How Much and Why', *Zycie Gospodarcze*, 27/18, 1970 (both in Polish).)

It was only later on that Mieczysław Nasiłowski made another attempt to test statistically Kalecki's equations. The purpose of Nasiłowski's studies was to estimate the effect of increases in productive capacity on the potential rate of growth of net output in a socialized industry. This potential growth rate was obtained from the investment projects completed in a given year. The difference between it and the actual growth rate was then corrected *in minus* to take account of the fact that new plants enter production throughout the whole year, and not at its beginning (and even after they enter, for a number of reasons their capacity is not immediately fully used), and *in plus* to account for additions to the potential growth rate resulting from projects approaching full capacity utilization, but completed prior to the period in question. According to Nasiłowski, only on the basis of such an expansion of the investment term in Kalecki's growth formula is it possible to estimate the impact of the so-called non-investment factors as a residual in the rate of growth of production or national income (see M. Nasiłowski, 'Kalecki's Formula Expanded and the Idea of a Labour Model', *Ekonomista*, 63/4, 1973; *An Analysis of the Factors of Economic Growth in the Polish People's Republic*, Warsaw, PWE, 1974; 'The Application of Kalecki's Formula to the Analysis of Economic Development', *Ekonomista*, 65/5, 1975 (all in Polish)).

These studies, and subsequent research by J. Goldman, provided a better foundation for Kalecki's model (see J. Goldman, 'The Rate of Investment in the Context of the Kalecki's Model of Economic Growth under Socialism', in *Economic Growth and Resources, Trends, and Factors, Proceedings of the Fifth World Congress of the International Economic Association*, Tokyo, 29 Aug.–3 Sept. 1977, vol. ii, London, Macmillan, 1980; see also A. Szopa, 'Adaptation of M. Kalecki's Growth Formula to the Empirical Analysis', *Ekonomista*, 72/5–6, 1982 (in Polish), and W. Koziński, 'An Estimate of Michał Kalecki's Growth Equation: The Case of Polish Economy, 1961–1980', *Oeconomica Polona*, 13/2, 1986)). However, as with the earlier studies of Goldman, Flek, and Nachtigal, the subsequent investigations concentrated on a few selected elements in the Kalecki model only.

Directions for further research[1]

Kalecki's theory of growth, or—in accordance with his own views—an outline of this theory, arose in opposition to the 'hurrah-optimistic' approach that saw a sufficiently high rate of accumulation as the means to realize even the most ambitious plans to increase living standards. Kalecki showed that, if the planners' objective function is indeed the growth of consumption, then not every strategy accelerating the growth of national income must benefit consumption in the long run. Moreover, it is not necessary to accept every strategy for raising the rate of economic growth even if it promises benefits for

[1] This section draws largely on J. Osiatyński, *Michał Kalecki on a Socialist Economy*, pp. 125–8.

consumption in the long term. It is always necessary to set future benefits against current costs. Any conclusion that arises from such a calculation must depend on a political assessment of the relative value of incremental and opposite changes in consumption today and tomorrow.

This is the central theme of the *Introduction*, as it was the central problem in assessing economic development policies in Poland during the 1950s, and in defining their theoretical foundations later on. In formulating and solving this problem lay the strength as well as the weakness of the *Introduction*. The assumptions and analytical tools that Kalecki deployed in this book were developed by him in order best to serve its central theme, and not the problems of socialist economic growth in general, or the actual problems that revealed themselves many years later.

For example, Kalecki was convinced that the socialist economy has virtually unlimited possibilities of expansion, but he never studied this issue. In the late 1970s, the rate of economic growth in the centrally planned economies slowed down, and a recession followed in the late 1980s. In examining the causes of this, a reading of Kalecki's *Introduction* turns out to be of little help; the issues tied up with the long-term possibilities and barriers to economic expansion of the centrally planned economies are not investigated here, nor in his other works. It is also unclear whether his analytical model can be successfully adapted to the study of these problems.

A second set of problems which is not found in Kalecki's analysis, but which is related to the previous one, is how the theory of growth in a socialist economy links up with development theory, that is, how economic growth is tied in with regional development, structural problems, the social distribution of income, environmental protection, and so on. In some of Kalecki's studies (generally not those directly concerned with the problems of economic growth) it is possible to find signposts on the direction of his thinking about particular issues, which indicate that he was aware of their significance (see e.g. Part 3, this volume). But he did not concern himself with the problems of socialist economic development.

More intensive studies aimed at integrating the theory of growth with development theory were undertaken only in the 1970s. These used analytical tools taken from systems theory and the concepts of entropy and negentropy. Great hopes were attached especially to systems theory which was seen as a useful way of codifying the main economic variables and relationships. Yet the first theories of socialist economic growth based on system analysis and rejecting the causal relationships postulated by Kalecki have their own serious limitations. The conclusion that in a system of interlinked elements, everything interacts with everything else, whatever the number of individual elements seems somewhat trivial.

Each element that is identified in such a system becomes a growth factor. Without introducing what are in the nature of things arbitrary criteria of division into primary, secondary, and other factors, a causal analysis of growth becomes, on this approach, impossible.

The above-mentioned and rather wide-ranging problems are not dealt with in the *Introduction*, and indeed could not be found in it since, at best, the theory that it advances could be only a part of a more general theory devoted to explaining these problems. But the *Introduction* is also based on two very specific assumptions which, although related more to growth theory than to the theory of socialist economic development, nevertheless have important consequences for the latter. Maintaining these assumptions distances Kalecki's theories from the problems which more recently became critically important for the growth of socialist economies. The first of these is the technical progress function; the second concerns the motivation and behaviour of economic decision-makers; both are intimately interlinked.

In Kalecki's theory, technical progress is determined exogenously. The distance between isoquants of production in time t and $t + 1$ may change with the capital intensity of production (this in fact constitutes the criterion for identifying various types of technical progress). But regardless of the kind of technical change, the question remains as to what determines the distance between one curve of production and another. If we reject the assumption that technical progress falls indiscriminately, like 'manna from heaven', then we are faced with two fundamental questions.

First of all, we have to define a function which would link the rate of innovation in socialist enterprises with the stream of new inventions. The latter in turn would need to be linked to the level of expenditure on basic and development research, patent and licence purchase policies, and so on. (Indeed, Kalecki spoke of the need to incorporate these factors into his growth model during the conference at SGPiS, in 1968, see p. 262 above.)

Secondly, it requires a definition of the conditions under which, broadly speaking, the demand for new inventions would meet the supply for them. (In fact, in improving the efficiency of production processes and introducing improvements in the quality of output in the course of production, distinguishing between supply and demand factors makes little sense. In such cases, the way in which the economy functions will determine the enterprise's interest in innovation at all stages.) These are the conditions that would link the attitudes of enterprises towards technological advance with their reward systems, the way in which they are supplied with fixed and circulating capital, credits, and labour, and the rules governing government intervention in the production and investment activity of enterprises. In other words, the way in which

technical progress proceeds would have to be integrated with the ways in which enterprises operate (for an examination of some consequences of lifting Kalecki's assumption of exogenous technical progress, see papers by S. Gómułka quoted on p. 270 above).

At this point, the problems of growth again link up with the problems of how an economy operates, and they require the lifting of Kalecki's second assumption. That is, that the way in which an economy functions in a given period is a neutral factor in relation to the growth of labour productivity, technical progress, and so on, on the one hand; and in relation to the rate of increase in employment, on the other hand; or, if not, that it merely affects coefficient u in Kalecki's growth equation. Undoubtedly this assumption can no longer be defended in the light of more recent experience of the USSR and other countries of Central and Eastern Europe.

[2]
See *Collected Works of Michał Kalecki*, vol. iii.

[3]
Starting with the paper in which he has challenged the dogma on the primacy of development of Department I over Department II, Kalecki remained persistently opposed to propositions which would maximize consumption over the long run, but would seriously reduce consumption in the short run. In many debates he opposed the mechanical following of the golden rule of accumulation in economic planning. This growth path, he argued, could prove to be unacceptable from the point of view of current consumption. For similar reasons he criticized the 'accumulation equation' of Bronisław Minc and Wacław Przelaskowski, which he viewed as a crude attempt to justify the high share of productive accumulation in national income with the expected beneficial impact on consumption in the long term. Kalecki's criticism of these ideas follows below in Annex 3.

ANNEX 3
Accumulation and the Maximization of Consumption[1]

1. Nearly two years ago I was shown a study on the determination of the share of investment in national income through the maximi-

[1] The article was first published as 'Akumulacja a maksymalizacja spożycia', *Ekonomista*, 55/2, 1962. In the same issue of the journal the rejoinder of

zation of total consumption over the period of a long-term plan. When subjected to a mathematical analysis, this method yielded effects which were rather unexciting. Over a twenty-year period productive investment should amount to about 80% of national income. This is not as strange as it would seem. The high share of productive investment in the first few years of the long-term plan allows an acceleration in the rate of growth of national income and raises it to such a level that the volume of consumption is higher not only in the period of growth acceleration but in fact throughout the whole long-term plan period, compared to what it would have been if the share of investment had been lower. However, things which are understandable are not always desirable. Even if someone did not mind the suffering of the unfortunate population in the first years of the long-term plan, he would still have to realize that given the initial level of living standards corresponding to this exorbitant share of accumulation in the first few years of the plan, the population would quickly die off and thus fail to fulfil this plan. I therefore suggested that the author should be strongly recommended to refrain from publishing his paper.

2. The idea of a relationship between the period over which consumption is optimized and the share of productive investment in national income resurfaced in a new form in a recent article of Minc and Przelaskowski.[1]

The authors limit themselves to establishing a functional relation between the two variables and to calculation of the period for which consumption is optimized under the current Polish conditions. They derive the following equation

B. Minc and W. Przelaskowski appeared ('Once Again on Accumulation and Maximization of Consumption' (in Polish)). Its authors pointed out that the main purpose of their article was 'only to show the functional relation between the share of net productive accumulation in national income (x), and the time (t), given the length of the investment construction period and the efficiency of investment a' (ibid., p. 710). In conclusion, they maintained their criticism of ideas that 'the high share of investment in national income in the socialist countries leads to the current generation making sacrifices for the sake of the future one. . . . It was demonstrated that this period is much shorter and investment gives consumption effects already within 11 years, i.e. during the current generation's lifetime. . . . This is also confirmed by observation of the reality. The great efforts of People's Poland during the Six-Year Plan [1949–55] are giving consumption effects which are already tangible' (ibid., p. 721).

[1] See their 'Accumulation Equation: Accumulation and the Maximization of Consumption', *Ekonomista*, 54/6, 1961 [in Polish].

$$atx^2 - a(t-1)x + 1 = (1+ax)^{1-t}$$

where x is the share of net productive investment in national income, a is the coefficient of efficiency of investment (a ratio of an increment in national income to one złoty of net investment), and t is the period over which consumption is maximized. Assuming for Poland in the years 1957–60 that $x = 11.7\%$ and $a = 1/3$, from this equation they obtain $t = 11$ years. This result (as it follows from their argument on p. 1218 of the article) is approximate. This is a very rough approximation indeed, since in fact t is close to eight years. This error is not fundamental, however. The real drawback to their study is that they did not calculate the value of t for other values of x since, as we shall see, such calculation sheds more light on the applicability of their equation 'for the practice of economic decision-making and planning of the national economy'.[2]

3. I made such a calculation, the results of which are as follows:

The share of net productive investment in national income, x (in %)	The period of optimization of consumption, t (in years)
close to 0	close to 7
11.7	8
34	10
50	12
65	15
75	20

Plotting x as the abscissa and t as the ordinate, we can draw the relations between them, as in Fig. 42.

It appears that the fantastically high shares of investment in national income are necessary not only for the twenty- or fifteen-year periods of maximization of consumption. Already for twelve years x is equal to 50%, and even for ten years $x = 34\%$. On the other hand, if the present period of maximization of consumption is reduced by just one year, i.e. from eight to seven years, the share of investment falls to zero and simple reproduction becomes optimum.

[2] Ibid., p. 1219

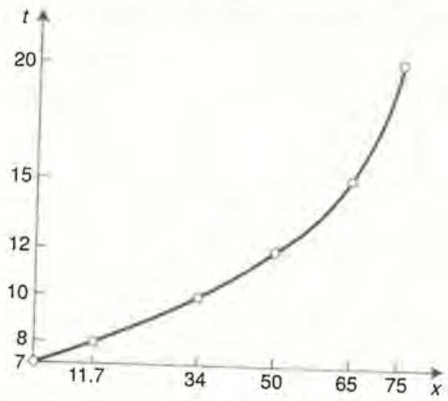

FIG. 42

It directly follows that the criterion of maximization of consumption 'for economic decision-making' is completely useless. Heroic efforts must be made in order to obtain only a modest extension of the optimization period. Is it worth while to increase x to 34% in order to extend t from eight to ten years? The answer is probably in the negative since the benefits from maximizing consumption over ten years instead of eight will not be considered as very impressive, whereas the share of investment will have to soar from 11.7% to 34% of national income, which is a very large increase indeed. With such an approach it becomes debatable whether it is not worthwhile to maximize consumption over seven instead of eight years, and to get rid altogether of net investment as such.

Thus, an article which apparently was supposed to justify the high share of accumulation in national income through its impact on maximization of consumption in the long run, paradoxically leads to quite opposite, and at the same time false, conclusions.

4. Furthermore, the argument put forward in this article is based on the tacit assumption that in order to accelerate the growth of national income it suffices to increase the rate of accumulation, provided that the coefficient of efficiency of investment is constant. Such reasoning is correct only in the case when acceleration of growth does not encounter any physical barriers, and especially a shortage of labour. If it does, such a barrier can of course be overcome through an increase in investment outlay. However, we then have to abandon the assumption that the efficiency coefficient a is constant, and the whole argument becomes much more complicated. The authors, who failed to take these complications into account, should in any case have been more specific about the character of their assumptions.

Kalecki's criticism of the standard concept of the golden rule of accumulation notwithstanding, his own approach is based on a similar rule. While the former stresses the maximum limit to the increase of the share of capital accumulation in national income from the point of view of a rise in national income, Kalecki introduces a stricter limit beyond which increasing the share of capital accumulation does not raise maintainable consumption levels. Moreover, his rule holds also in a model of an open economy with technical progress, as long as this is neutral in Kalecki's sense, i.e. when the rate of growth of labour productivity is the same for all capital–output ratios (see D. M. Nuti, 'Michał Kalecki's Contribution', p. 338).

In contrast to the golden rule concept, Kalecki argues that his concept of a maximum limit to the share of capital accumulation should not necessarily be met since the central planners may consider the benefits of higher consumption in the long run, due to acceleration of growth of national income, not to outweight the costs expressed in terms of short-run cuts (relative or absolute) in consumption. (The process of weighting short-run costs against long-run benefits is represented in the Kalecki's concept of central planners' 'decision curve' which assumes an increasing supply price of savings expressed in terms of acceleration of growth of national income.) According to Nuti, however, Kalecki's rule is also debatable, since:

> *Kalecki's contentions about either the golden rule limit of the planners' increasing supply price of savings have no general validity* [although] *he was right in the specific conditions* of Eastern Europe at the time. . . . The adoption of more capital-intensive techniques than those which satisfy [Kalecki's] condition . . . cannot be regarded as *necessarily* mistaken: in principle—as long as the new technology is not absolutely inferior . . . —that policy can always be reversed and will lead to a higher consumption than with the less capital-intensive technique throughout the period of transition back to that technique. This gain in consumption may be considered as insufficient to compensate for the sacrifices incurred during the transition to the more capital-intensive technique and before the policy is reversed; but this is a political judgement, not a technical one as Kalecki would have us believe. (D. M. Nuti, 'Michał Kalecki's Contribution', p. 390.)

In 1985 the very relationship between the share of capital accumulation in national income and the rate of growth of national income was put into question in two different institutional settings. The first refers to the post-war Latin American economies, where the rate of growth was determined by demand conditions rather than by capacity limitations (see J. Lopez, 'The Post-War Latin American Economies: The End of the Long Boom', *Banca Nazionale del Lavoro Quarterly Review*, 7/154, 1985, pp. 237–8; Lopez's findings, however, are not surprising in the context of Kalecki's own ideas, see e.g. his 'Theories of Growth in Different Social Systems', this volume, and his works on the 'mixed economies', *Collected Works*, vol. v).

The second objection explicitly addressed the setting of a centrally planned economy. It pointed out a partial, *ex ante* disequilibria in monetary and physical flows of national product and national income, which gave rise to such behaviour of individual firms and households that undermined the relationship between gross capital formation and the economic growth rates, as well as between the capital–labour ratio and labour productivity, which is assumed both by central planners and in the standard growth theory (see L. Zienkowski, 'Theory and Practice of Macro-economic Planning', *Gospodarka Planowa*, 40/10, 1985; see also n. 1).

[4]
In the Polish editions of the *Introduction* there follows a note in which Kalecki explains that in his earlier 'Problems in the Theory of Growth of a Socialist Economy' (see *Collected Works*, vol. iii) he used a different typology, calling technical progress capital-intensive, neutral, and capital-saving if the capital–output ratio actually increased, remained constant, or declined respectively (this did not prevent him from examining there the case when after an initial increase in the capital–output ratio it was maintained at a stable level, and therefore the rate of growth of labour productivity was temporarily reduced).

When compared with Kalecki's earlier typology this change in the criterion of classification caused some confusion. Many years after it was published, one could still encounter studies attributing to Kalecki the criteria which he had since long abandoned. This was partly because the earlier definition was simpler. It was also better adapted to the interpretation of statistical series on the volume of capital, investment, output, national income, etc.; it represented economic policy choices made in the past and from which one could reconstruct the actual growth path of a given economy. In this sense, the old definition looked at the past. The new definition, on the other hand, looked into the future. In line with the general philosophy of the *Introduction*, its purpose was to provide the central planner with criteria of choice to be made among the alternative growth strategies.

For a comparison between Kalecki's classification of technical progress and those of J. R. Hicks and R. F. Harrod, see e.g. A. Chilosi and S. Gómułka, 'Technical Progress and Long-Run Growth', and K. Łaski, *The Rate of Growth and the Rate of Interest in the Socialist Economy*, ch. 3).

On the difference between Kalecki's interpretation of technical progress and that of G. A. Feldman, Kalecki wrote:

> For Feldman, technical progress has a meaning which is different from the standard use of this term. In his meaning technical progress refers mainly to a better utilization of the already existing capital equipment and its modernization. Otherwise it would be hard to understand why for Feldman technical progress is always reflected in increased efficiency of capital or in falling capital–output ratios. (Excerpt from Kalecki's unpublished review of A. Łukaszewicz's thesis on 'The Problem of Accelerated Growth in a Socialist Economy and G. Feldman's Theory'; undated draft of the review is in Kalecki's files.)

[5]
The problem of joint optimization of capital intensity of output and of durability of equipment was taken up by W. Sadowski and C. Józefiak (see p. 250, this volume). Sadowski attacked the problem within the framework of his own theoretical construction characterized by a specific method of measuring stocks (of capital and labour) and flows (of output, national income, and investment); this resulted, *inter alia*, in rather unusual relations between the model's variables (see W. Sadowski, 'The Optimum Capital–Output Ratio and the Optimum Life-Span of Equipment', and 'Technical and Restitution Optimum'). Józefiak, on the other hand, searched for a solution to this problem within the framework of Kalecki's model and ended with somewhat different results from those of Sadowski. Discussing his results Józefiak also attempted to explain the differences in the two approaches (see his 'Technical and Restitution Optimum under Steady Growth'; for the subsequent debate between the two authors, see *Ekonomista*, 58/5, 1965 (both in Polish)).

[6]
In June 1965 Kalecki took part in the Reunion of Latin American Schools of Economics, in Mexico City. At the Higher School of Economics, in Mexico City, he read a paper on 'Determining the Rate of Growth of a Socialist Economy under Conditions of Unlimited Supply of Labour'. Its revised Polish version appeared as 'Zagadnienie określania stopy wzrostu gospodarki socjalistycznej w warunkach nieograniczonej podaży siły roboczej', *Prace i Materiały*, Centre of Research on Underdeveloped Economies, 4/2, 1966, pp. 5–17, and then, as 'Tempo wzrostu gospodarki socjalistycznej w warunkach nieograniczonej

podaży siły roboczej a kapitałochłonność', in *Ekonomista*, 59/6, 1966, pp. 1269–78. The German translation, 'Das Problem der Wachstumsrate einer sozialistischen Wirtschaft unter der Bedingung enbegrenzten Arbeitskrafteangebots' was published in *Jahrbuch für Wirtschaftsgeschichte*, 8 1967, pt. 2, pp. 51–64. The English translation appeared as 'Determination of the Rate of Growth of a Socialist Economy under Conditions of Unlimited Supply of Labour' in *Essays on Planning and Economic Development*, vol. iii, Warsaw, PWN, 1968, pp. 19–34. The Portuguese translation, 'Determinação da taxa de crescimento de uma economia socialista subdesenvolvida', was published in J. Miglioli (ed.), *Kalecki Economia*, São Paulo, Editora Ática, 1980.

Chs. I, II, and III of this article, which served as an introduction to the problem, were in fact a brief summary of the corresponding fragments of the 1st edn. of the *Introduction*. Beginning with the 3rd paragraph of Ch. IV of the article, Kalecki incorporated its text (with small editorial changes) in sections 6 to 8 of Ch. 10 of the 2nd edn. of the *Introduction*. Thus, in its first five sections, in which Kalecki confronts his argument with that of Dobb and Sen, Ch. 10 of the *Introduction* differs from this article (this explicit confrontation was altogether absent from the 1966 version of the article).

Until the mid-1950s, the debate on the choice of techniques of production under abundant supply of labour, characteristic of developing countries, was dominated by the view that they should rather opt for low capital-intensive techniques. Oskar Lange even defined an undeveloped economy as such 'in which the available stock of capital goods is not sufficient to employ the total available labour force on the basis of modern production techniques' ('Some Problems concerning Planning in Underdeveloped Countries', in O. Lange, *Problems in Economics and Sociology, 1930–1960*, Warsaw, PWN, 1970, p. 171).

This idea was first challenged by W. Galenson and H. Leibenstein ('Investment Criteria, Productivity and Economic Development', *Quarterly Journal of Economics*, 69/3, 1955) and then by M. Dobb (*An Essay on Economic Growth and Planning*, London, Routlege & Kegan, 1961) and A. K. Sen (*Choice of Techniques*, Oxford, Blackwell, 1960). Dobb and Sen introduced a new element into the debate: assuming that the initial level of real wages in no case may be lowered, they demonstrated that the economic surplus (in the sense of a difference between the national income produced and the total wage bill) is an increasing function of the capital–output ratio. In their opinion, this justified (wherever possible) the use of capital-intensive production techniques under conditions of a surplus of labour (while Dobb was resolutely committed to this solution, Sen considered it to be merely a viable option).

It seems that Kalecki's critique of the Dobb–Sen solution in one point fails strictly to reflect their ideas. When he demonstrates that once technical progress is taken into account the choice of relatively more capital-intensive methods of production becomes less attractive, Kalecki rests his argument on the assumption that Dobb and Sen had in mind a single 'recasting' of capital stock into more capital-intensive methods of production, and he examines the outcome of such a conversion. However, it may be argued that they thought rather of a *continuous* selecting of ever more capital-intensive methods of production, in every successive generation of investment. Allowing for this factor would complicate Kalecki's argument, but would not significantly alter his conclusions on the advantages of the solution favoured by Dobb and Sen.

Despite his critical position on the 'Dobb–Sen solution', Kalecki highly praised Dobb's contribution to the debate on the choice of production techniques in developing countries, and ardently sponsored attempts to give Dobb a honorary degree of the University of Warsaw. In his opinion of Dobb's scientific achievements he wrote *inter alia*:

> His main contribution to the field of planned economies was his analysis of advantages which capital-intensive techniques of production may offer to countries with a surplus of labour. This theory was presented in his book *An Essay on Economic Growth and Planning* (1960). Although I have myself been critical of the possibility of practical application of Dobb's theory, it is nevertheless one of the most interesting and most original contributions to the theory of growth in a socialist economy, which largely expanded the scope of debate on the problem of choice of techniques of production. (Kalecki's files; typescript dated 3 June 1967. In the aftermath of the March 1968 events in Poland the initiative of Kalecki, Brus, and Łaski to give Dobb a honorary degree could not be pursued.)

Among the Polish contributors to the debate there were mainly Kalecki's students (see e.g. Z. Dobrska, *The Choice of Techniques of Production in Less Developed Countries*, Warsaw, PWE, 1963; A. Müller, *Directions of Optimization of Production Techniques in Less Developed Economies*, Warsaw, PWE, 1966; K. Łaski 'On the Choice of Production Techniques in Less Developed Countries', *Ekonomista*, 59/3, 1966, and his 'Investment Criteria in Developing Countries', *Économies et Sociétés*, 4/1, 1970; A. Rybczyński, 'Criteria of Choice in Production Techniques in a Developing Economy', *Ekonomista*, 67/4, 1974 (all in Polish)).

[7]
This is a slightly revised and edited version of Chs. 2 and 3 of Kalecki's article 'The Curve of Production and the Evaluation of the Efficiency of Investment in a Socialist Economy' (see pp. 160–6 and 314, this volume).

Theories of Growth in Different Social Systems

[1]
The article was first published in English in *Scientia*, 105, May–June 1970, pp. 1–6. Its 2nd English edn. appeared in the *Monthly Review*, 23/5, 1971, pp. 72–9. The article appeared in the following translations: Italian, 'Teorie dello sviluppo in sistemi sociali differenti', in the Italian edn. of *Monthly Review* (Edizione Italiana, 4/11, 1971, pp. 10–12); Polish, 'Teorie wzrostu w różnych systemach społecznych', *Życie Gospodarcze*, 31/16, 1976; Portuguese, 'Teorias do Crescimento em Diferentes Sistemas Sociais', in M. Kalecki, *Crescimento e ciclo das economias capitalistas*, São Paulo, Hucitec, 1977, ch. 11, pp. 123–30; 2nd edn., 1980; German, 'Theorien des Wachstums in verschiedenen Gesellschaftssystemen', in M. Kalecki, *Theorie des Wachstums und der Planung in der sozialistischen Volkswirtschaft*, pp. 17–23; Hungarian, 'A különböző társadalmi rendszerek növekedési elmélete', in M. Kalecki, *A szocialista gazdaság működéséről: válogatott tanulmányok 1956–1970*, pp. 297–306.
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In the summer of 1969 Kalecki read this paper at the Faculty of Economics of the University of Cambridge. In the autumn of that year he read it also at a seminar run by Cezary Józefiak and Jerzy Łoś at the Computing Centre of the Polish Academy of Sciences.
The paper in a sense represented Kalecki's response to that criticism after the March 1968 events in Poland, in which his growth theory of a socialist economy was accused of being universal in character, making it equally applicable to growth in any social system (see pp. 258–62, this volume).

[2]
For a substantiation of this thesis, see Kalecki's 'Observations on the Theory of Growth' (*Collected Works*, vol. ii).

PART 2
Efficiency of Investment

Generalized Formula of the Efficiency of Investment

[1]
The paper, entitled 'Uogólnienie wzoru efektywności inwestycji', appeared simultaneously as an in-house publication of the Planning Commission, *Prace i Materiały Zakładu Badań Ekonomicznych Komisji Planowania*, 4/17, 1959, pp. 1–16; an article in *Gospodarka Planowa*, 14/11, 1959, pp. 4–7; and in *Inwestycje i Budownictwo*, 9/11, 1959, pp. 6–9.
Its English translation, entitled 'Generalization of the Pattern for Effectiveness of Capital Investment', appeared in *Eastern European Economics: A Journal of Translations*, IASP, 1/1, 1962, pp. 20–5. Another English translation, 'Generalized Formula of the Efficiency of Investment' was published in M. Kalecki, *Short Papers on Economic Growth*, Warsaw, Central School of Planning and Statistics, the Higher Course in National Economic Planning, Teaching Materials, vol.i, 1962, pp. 42–52; 2nd edn., 1964. The same translation then appeared in A. Nove and A. Zauberman (eds.), *Studies on the Theory of Reproduction and Prices*, Warsaw, PWN, 1964, pp. 189–201, and was later repr. in A. Nove and D. M. Nuti (eds.), *Socialist Economics*, Harmondsworth, Penguin, 1972, pp. 252–62. The Spanish translation, 'Formula generalizada de la eficiencia de la inversion', appeared in the translation of the book edited by Nove and Nuti, *Teoria economica del socialismo*, México, Fondo de Cultura Económica, 1978, pp. 235–44.
The PWN 1964 English edn. of this paper is followed in the present volume. The publisher's permission to reproduce this edn. is gratefully acknowledged.

Up to the mid-1950s, work on the theoretical foundations of investment efficiency calculation in Poland and in other communist countries lagged considerably behind practical requirements. Unable to find any support in theory, various methods of partial optimization were used in practice. These were based on criteria such as the lowest admissible rate of internal accumulation (or the lowest profitability norm), the pay-back period of additional investment outlay entailed by the choice of a more capital-intensive project, and so forth.

The debate on the theoretical foundations of economic calculation of investment efficiency in a centrally planned economy first started in the Soviet Union. In its first phase (1946–54) there were four identifiable approaches. The first was associated with the practice in investment design bureaux which applied 'financial accumulation norms', set arbitrarily by the central economic authorities, and similar yardsticks for calculating the return on investment. It was proposed to refine these norms and base the methods used for calculation of investment efficiency on some universal standard such as the average rate of return. A second view was put forward primarily by S. Strumilin. He proposed to base calculation of efficiency on the notion of depreciation payments for the use of productive equipment. He laid special emphasis on allowing for the time factor in the calculation. Then, there were various partial standards of investment efficiency that were widely used in Soviet investment design bureaux, such as the profitability period, and the pay-back period. These too had many supporters and were advocated by, among others, A. Lurie. (It is worth noting that, as early as 1946, he had pointed out that in a socialist economy, the national economic plan tells one *what* to produce, and investment efficiency calculation tells one only *how* to produce it. In his opinion, the latter calculation ought to secure the conditions for maximizing the growth of labour productivity in every industry and hence in the economy as a whole.) Finally, there were the advocates of a macro-economic approach to investment efficiency appraisal, who pointed to the necessity for comprehensive research on the effects of investment activity on various aspects of social and economic life.

In Poland, it was these last two approaches that won most support. In 1955–6 Bronisław Minc and Kazimierz Secomski advocated the macro-economic approach to investment efficiency theory. Józef Pajestka and, especially, Mieczysław Rakowski, although working within the framework of the fourth approach, were more inclined towards practical applications, and in this sense were closer to the third one. Kalecki entered this debate in the fall of 1956, when the parliamentary debate on the 1956–60 Five-Year Plan was postponed until the spring session of the Diet in 1957, and a special team under his direction was set up in the Planning Commission to work on improvements to the draft of this plan (see *Collected Works*, vol. iii, pp. 407–8). Among the achievements of this group was a thorough examination of economic efficiency of about thirty key investment projects in that plan. The results of this work were reported in Kalecki's article which follows below in Annex 4.

ANNEX 4

How to Mitigate a Contradiction between Investment and Consumption? (On Examining the Efficiency of Investment)[1]

The Team to Review Reserves in the Five-Year Plan, appointed last fall in the Planning Commission and working under my supervision, has just completed its work. The most important of its accomplishments is the examination of the efficiency of some thirty key investment projects in this plan. This analysis was conducted by the Investment Review Group headed by M. Bartnicki.[2] Of course, I cannot summarize their work here. I would only like to give some examples of the successful application of their studies.

1. Comparative study of the efficiency of investment outlay effected or planned in various collieries reveals that a reallocating of inputs *may* by 1960 lead to an *increase in the coal output by one million tonnes per annum without increasing the planned total capital outlay.*

2. This analysis laid great stress on the need to *economize the use of coal, which would allow an increase in exports.* The most essential and efficient investment in this field consists of introducing new equipment for the mechanical processing of coal (in order to improve its quality through elimination of pebbles and sorting, which provides important economies for its users), and replacement of obsolete and high coal-intensive power plants with more modern ones. This way of increasing the supply of coal available for export is much more profitable than investment in new collieries due to much shorter construction periods, lower or no operating costs, and avoiding the difficulties of recruiting workers in coal-mining.

[1] First published as 'Jak łagodzić sprzeczność inwestycje–konsumpcja? (O pracach nad badaniem efektywności inwestycji)', *Życie Warszawy*, 18 May 1957. The results of this analysis as well as of the methodological work carried out at the Economic Research Division of the Planning Commission led to the publication of the manual *The Study of Efficiency of Investment: Methods and Examples* (Warsaw, PWE, 1957 (in Polish)).

[2] It was called the Group of Experts for the Evaluation of Investment Projects at the Planning Commission; in 1964–9 it operated as the Bureau of Experts for Evaluation of Investment Projects.

3. The analysis demonstrated *high efficiency of processing in iron metallurgy*, such as production of zinc-coated sheets, welded pipes, curved profiles, wire, rope, etc. It is interesting to note that investment outlay per dollar earned in foreign trade through a reduction in imports or growth in exports is much lower at this stage of processing than in primary metallurgy.

4. The examination of the chemical industry pointed to a relatively *low efficiency of the present method of producing nitrogen fertilizers through coke-processing*. This is mainly because the world price of nitrogen fertilizers is low in relation to the price of coal, since they can be cheaply produced as by-products of oil-refining.

Another method of efficient production of fertilizers, as well as of other products of organic chemistry, is to base their output on coking and natural-gas processing. The analysis of efficiency of investment in the fertilizer industry shows that *the Polish gas resources*, so far used only for heating purposes, *should become an important factor of development in the chemical industry*. It must also be added that, as in metallurgy, *investment in the processing of semi-products into final chemical products*, such as plastics, *is often more effective than investment in industries which produce these semi-products*.

The results of this work were taken into account in the new draft of the Five-Year Plan, in which the structure of investment was changed in order to increase its economic efficiency without necessarily increasing capital outlay (for example, in coal-mining), or to mitigate the consequences of reduced investment outlay through rational selection of investment projects. However, a wider application of investment efficiency analysis is crucial to perspective planning and the construction of future five-year plans since in the present one the majority of the projects are already under construction, largely predetermining the structure of investment.

It is not by chance that this analysis has been initiated now. In the course of implementation of the Six-Year Plan, especially up to 1954, *the trend was to spend generously on investment since not enough attention was given to attaining high levels of consumption in the short run*. At present the contradiction is clearly seen between a desire to reach the highest living standards, even in the shortest term, through a large share of consumption in national

income and a rapid growth in income and consumption, which in turn requires a high share of investment. For instance, in order to increase current consumption investment is reduced. This slows down the future rate of economic development and thereby the possibilities of consumption growth in the long run. *One of the main ways of overcoming this contradiction lies in increasing the efficiency of investment outlay, which makes it possible to reach the same rate of economic development with a smaller share of investment and a greater share of consumption in national income.*

Up to 1959 Kalecki himself did little systematic work on the methodological foundations of calculating investment efficiency, except in supervising the research conducted in the Economic Research Division of the Planning Commission (mainly by Mieczysław Rakowski). In 1957–9, however, Kalecki spoke at a number of meetings of the Planning Commission's Board about the efficiency of various investment projects in the 1956–60 and 1961–5 Five-Year Plans, such as organization of the sulphur basin (see Record No. 4 from the session of the Planning Commission's Board, on 14 Jan. 1958, AKPRM, ref. no. 10/4), and on oil transportation. On this last subject there survived his written opinion:

Note on deliveries of oil through various means of transport

Included you will find the note of Mr B. Wojterkowski, from which the following conclusions can be drawn:

1. With respect to transporting oil from the USSR, a comparison of efficiency of investment shows beyond doubt that sending it by means of a pipeline—even from Briest, with Soviet deliveries to Briest by rail—is the best option. It is obviously much cheaper than transport by rail, and the efficiency of shipping it by sea is very low when compared to the pipeline.

2. However, in order to gain some flexibility in deliveries of oil it would be worth while to construct in Gdynia a relatively small oil terminal, which could annually handle some 1 million tonnes, and the capacity of which could be expanded. While the cost of a terminal capable of handling 2 million tonnes of oil per annum is estimated at zł. 250 million, that of a 1 million tonnes capacity should be some zł. 160 million; it cannot be ruled out that expanding it to the capacity of 2 million tonnes in the second stage would cost slightly less.

3. An oil terminal of 1 million tonnes corresponds to the capacity of six tankers 18 000 d.w.t. each. The purchase of these

tankers does not involve such a high risk as construction of the terminal since they can be chartered out. From this point of view the purchase of more tankers may be considered.

4. Given the above, it seems reasonable to accept the Shipping Ministry's order for at least six tankers, as well as to prepare specifications for an oil terminal with ultimate capacity of 2 million tonnes, the construction of which should be split into two phases. The first phase, consisting of construction of a terminal handling 1 million tonnes of oil should be kept relatively inexpensive. (AKPRM, ref. no. 10/12.)

Between 1956 and 1959 a large number of studies of the economic efficiency of investment projects in various industries was completed. Most of them followed the methods of calculation recommended in the *General Guidelines for Examining the Economic Efficiency of Investments* (prepared in 1956 in the Planning Commission by a team headed by Mieczysław Rakowski). These studies provided ample material for testing and revising the *General Guidelines*. This task was undertaken by Kalecki who was asked to take charge of the Methodology Section of the Second Conference on Investment Efficiency Analysis. In the course of that work Kalecki and Rakowski prepared a new and radically different set of rules for calculating the efficiency of investment.

The conference was preceded by another meeting, held in Warsaw on 15–16 June 1959, and devoted to three subjects: (i) the proposed changes in the methodology of calculation of the efficiency of centralized investment, (ii) the methods of calculating the economic efficiency of decentralized investment, and (iii) the directives on measures to be applied to the scaling down of investment outlay for 1959. The conference was opened by Kalecki; the proposed changes (following the theses put forward in the 'Generalized Formula of the Efficiency of Investment') were outlined by Rakowski.

Compared with the *General Guidelines*, the new draft of the manual recommended that, in addition to the productive effects promised by alternative investment variants, account was now to be taken of their respective savings in inputs of resources and foreign exchange, of their respective degree of capacity utilization, of economic efficiency indicators not only for the durability of the plant as a whole, but also for shorter subperiods and even individual years. Attempt was also made to eliminate price deformations in estimating the value of output, e.g. through the use of the so-called net foreign exchange earnings, etc. The results of the second stage of the Soviet debate on investment efficiency analysis were also taken into account in the new proposals.

Eighteen speakers took the floor to comment on the proposed new methodology of investment efficiency calculation. Their attention focused on taking into account the factor of time. Many of them suggested various extensions of the new guide-lines; many heavily criticized them (see *Gospodarka Planowa*, 14/8, 1959, and *Inwestycje i Budownictwo*, 9/7–8, 1959 (both in Polish)). Kalecki's contribution, which closed the debate, follows below in Annex 5.

ANNEX 5

On the Methodology of Examining the Efficiency of Investment[1]

I would like to start by clearing up some misunderstandings. First of all, unlike medical doctors, we cannot study the consequences of various options. In order to see what is going to happen to the economy which opted for one path of development and not another, we have to wait fifteen years, and even then if we note some improvement it does not necessarily follow that this was because the right method of evaluating the efficiency of investment was selected. The methodological issues have to be solved on the basis of some theory.

Secondly, in my opening address I said that methods of examining the efficiency of investment are an essential element of rational economic calculation. This is doubtless the case; however, we should not overestimate their role. The examining the efficiency of investment is in fact restricted to two cases. The first one is the possibility of attaining a given use-value through alternative methods, for instance, we can produce the same number of various ceramic objects in various ways and we examine which of them is the most efficient. The second case concerns foreign trade, e.g. is it more profitable to export pipes or machinery? In this case we must also remember, however, that although our calculation may show production of machinery to be more profitable than that of pipes, it does not necessarily

[1] First published in *Inwestycje i Budownictwo* 9/7–8, 1959, pp. 9–10 (in Polish), as an unheaded contribution by Kalecki to the debate; the title of the summary of the whole debate, 'W sprawie metodologii badań efektywności inwestycji', was used by the present editor as the heading for Kalecki's contribution. Publisher's permission to reproduce it is gratefully acknowledged.

follow that we shall export machinery, because it may be hard to sell it on world markets.

Thirdly, in the course of discussion it was claimed that a high rate of interest slows down technical progress. This is not true, for instance, with respect to the power industry where the use of huge aggregates not only reduces the unit cost of fuels, but also investment outlay per unit of output. In this case high interest rates have no negative effect on technical progress since technical progress does not lead here to a higher capital intensity of production.

The case of hydroelectric power plants and that of electrification of the rail system is different. However, it must be noticed that setting high interest rates is not something entirely revolutionary compared to the methods currently in use, since in the decision-making process we have so far been taking into account both the efficiency and the capital intensity of production. Even at an interest rate of 7% only, investment in hydroelectric power plants appeared to be of a doubtful profitability. If a higher rate of interest was set, it would not be necessary to take into account the value of the capital–output ratio.

Moreover, high interest rates often do not eliminate certain variants, but may even lead to their improvement. Let us look, for instance, at electrification of the rail system: even at an old rate of interest the efficiency of this project was not encouraging. Its further examination gave birth to the idea of a system of large arterial railroads on which the electrification effort would be concentrated.

I will now turn to the idea which was brought up in the discussion. No one advocated discarding interest cost altogether, i.e. to apply an interest rate equal to zero. However, there emerged two ideas, supported mainly by the power industry, which are practically equivalent to each other. The first one is that of a 'progressive depreciation', calculated in such a way that the sum of depreciation charges and interest on non-depreciated assets is constant. The second idea is that of cost-discounting. In the case of constant operating costs, both ideas lead to identical results. First of all, the use of the 'progressive depreciation' method appears to me unnecessary. It is an artificial method, the main purpose of which is to render the same result as in the case of cost-discounting.

The cost-discounting method consists of calculating the current value of investment outlay and operating cost throughout the whole period of the plant's operation. This value is then divided by the value of the plant's total output throughout its operating period at current prices. I am not advocating the use of this method since in a socialist economy with full employment I see no theoretical justification for it.

This method is appropriate to a profit-maximizing capitalist enterprise which compares the profitability of investment in fixed capital with investment in bonds offering a constant rate of return, in order to find the most profitable solution. It is possible to imagine a socialist economy in which the discount method could be used. This would be an economy with unlimited labour reserves, whose aim would be the maximization of accumulation. In reality, however, full employment may be assumed in a socialist economy, and its aim is the maximization of national income.

Let us suppose, nevertheless, that we decided to use the discounting method. Immediately, there arises the problem of what rate of discount should be used. It was suggested that the rate of interest equal to the rate of accumulation of fixed capital should be used for this purpose. This seems to me to be a confusion of two different concepts.

Such an interest rate could be incorporated into current prices in order to spread the burden of accumulation in proportion to fixed capital in each industry. However, why should that rate of interest be suitable for comparing the efficiency of different investment projects? I consider this idea to be as dogmatic as the one that there should be no interest charges on fixed capital at all. Should the supply of labour have no bearing on the interest rate used in the selection of investment projects? For a given rate of capital accumulation, should the same rate of interest apply, regardless of the growth of labour supply?

I now turn to the draft of the manual. The formula for the efficiency of investment must above all allow for rational choice between investment variants, of which one is more capital-intensive but has smaller operating costs.

The proposed rate of interest is derived from the recoupment period of outlay on mechanization. Our experience shows that within five years the outlay for mechanization can be paid back. Taking this period as a limit will protect us from choosing labour-saving projects in cases where these savings cost more. The assumption that outlay destined to reduce operating costs should pay for itself within five years is equivalent to a 15% interest rate with a durability period of equipment equal to twenty years.

I used to have some doubts about the applicability of this formula to economies of raw materials since their extraction can encounter difficulties of a technical and organizational nature. I now think that this formula can be applied there too, since I expect prices of raw materials to be set at a level which takes these difficulties into account.[2]

What I have already said does not exhaust the subject of interest on fixed capital since my argument is precise only as long as the durability period n is the same for all investment projects, e.g. it is equal to twenty years. The matter becomes much more complicated if in one case it equals twenty, and in another forty years. It appears to me that in order to take into account differences in the durability period it may be necessary to make the rate of interest depend on n and to apply lower interest rates to plants of a longer life-span. This is a very important question and it should be further examined by the working group. If my hypothesis is right, then the formula would have to be corrected.

There remains the problem of prices. The manual settled for a compromise solution. A price reform, based on rational economic criteria, is to follow soon. However, it is doubtful whether these prices will include interest on fixed capital. The proposed compromise method requires that interest at intermediate stages of production is charged. This may cause difficulties for project analysts and therefore it would be useful to provide them with a table of capital–output ratios for more important products. Until the price reform is introduced, the prices tentatively estimated by the Price and Cost Department of the Planning Commission can be used in the investment efficiency calculations. It is also possible to work out a separate price list specifically for calculation of investment efficiency; these prices would take into account the rate of interest used in those calculations.

In conclusion I can say that the guide-lines submitted under consideration can be accepted after some corrections.

[2] See Kalecki's 'Observations on Pricing of Basic Raw Materials', *Collected Works*, vol. iii.

Further work and discussions led in the course of the next few months to the drawing up in the Planning Commission, under the supervision of Kalecki and Rakowski, of a new *General Instruction on the Methodology of Analyses of the Economic Efficiency of Investment* (Warsaw, Komisja Planowania przy Radzie Ministrów, 1960 (in Polish)). The new instruction provided more thorough methodological foundations for such calculations, primarily in the following respects:

(1) The criteria for assessing the efficiency of particular projects are more closely linked to the general problems of extended reproduction, and especially to the maximization of national income with given material and labour resources. This allows the replacement of many arbitrary criteria of efficiency which were used hitherto with those which have a solid theoretical backing.

(2) In examining particular investment projects, allowance is made for variations in their subsequent conditions of operation and their economic environment.

(3) The general methods of analysing efficiency are modified and adapted to particular activities such as international trade and co-operation, the extension and modernization of existing industrial capacity, and agriculture.

(4) Attempts are made to apply input–output analysis and linear programming in the analysis of infrastructural investment, the optimum conditions for industrial co-ordination between plant of widely differing economic characteristics, and so on.

(5) Studies of investment efficiency in the development of whole industries and economic sectors over long-term periods of time are undertaken. (M. Rakowski, 'Introduction' to the *Efficiency of Investment*, Warsaw, PWE, 1961, pp. 3–4 (in Polish).)

The General Instruction revealed even more clearly the complexity of methodological and accounting problems involved in examining investment efficiency and showed that sometimes these problems altogether precluded an unambiguous solution. This is because the effectiveness of an actual investment undertaking is always tied up with future economic conditions which cannot be forecast precisely. There are also difficulties in summarizing economic relationships in any regular mathematical functions.

Soon after *The General Instruction* was published, in his letter of 20 Aug. 1960, Kalecki wrote to Stanisław Braun on the application of investment efficiency calculations in a socialist economy, and on further research in this field:

Dear Stach,

Thank you for your long letter which I read with interest. I don't quite see why your chapter has been so much criticized. It appears to me to be well written, although I would myself express some ideas in a different way. Especially, you could have placed more stress on the fact that determining the main directions of development through efficiency of investment calculations makes no sense even if the price system were perfect.

Let us imagine an economy in which: (i) technological methods of attaining a given result are predetermined, (ii) the economy is closed, and (iii) the structure of consumption is determined for each point on its development path. Then, for such an economy, the calculation of the efficiency of investment would be useless. Such calculation is applicable only to: (1) the choice of the best technological method of attaining a given production effect; (2) the selection of appropriate export-orientated or import-substituting investment; (3) the achievement of an appropriate structure of consumption.

This last objective is very difficult since it requires the knowledge of the price elasticity of demand for various consumption goods. Therefore, so far we have concentrated on (1) and (2). (An extract from Kalecki's letter, a copy of which is in his files (in Polish).)

In October 1960 Kalecki left Poland on a three-month mission to Cuba (for his report on the Cuban economy, see *Collected Works*, vol. v). On his way back he stopped in Oxford, where from mid-January to mid-March he lectured, *inter alia*, on the efficiency of investment. (His paper on investment efficiency calculations in a socialist economy prompted one of his listeners, Mr J. Black, to compare the criteria put forward by Kalecki with the profit-maximization criterion used in the market economy; Mr Black's note survived in Kalecki's files.)

The article of Kalecki and Rakowski, together with the general instructions on investment efficiency calculation, published in 1960 and 1962, stimulated further research on the subject, both in Poland and abroad. Kalecki found the attempts of an Indian economist, P. C. Sah to be of particular significance. In a letter to Kalecki of 4 May 1964 Sah wrote:

Respected Professor Kalecki,

Trust this will find you in the best of health and [good] cheer. I intend going over to Warsaw after July 1965 in order to complete my work towards a Ph.D. degree for which you very kindly consented to guide me. I shall be extremely grateful to you if you could let me know the exact time when I should come depending on your convenience. I am looking forward eagerly to the day when I will start work under your able guidance.

As a part of my thesis, I wish to develop a criterion for comparing the efficiency of investment on the analogy of the formula used in Poland. I feel, however, that while considering the effect of differences in the durability of plants one fact has been ignored in the formula: when a plant requiring less capital is selected, the balance of the capital can be invested in some other project which will result in additional output; this fact has not been taken into consideration. Because of this fact in some cases while the formula may favour one plant, it may be advantageous to adopt the other one; in the attached note I have worked out some such examples. In the first case I have worked out the formula for the economy in which there is no increase in investment. The last example, however, assumes the rate of increase in investment equal to 7%.

I shall be extremely grateful if you would kindly go through it and favour me with your comments.

With best regards,

Yours sincerely,
[signed: Pramod Chandra Sah]

(The letter and the note mentioned therein, are in Kalecki's files. In 1968 Sah got his degree for the thesis on the 'Evaluation of the Efficiency of Investment in Underdeveloped Economies with Surplus Manpower'; Kalecki considered Sah's thesis outstanding.)

Amit Bhaduri found the standard approach of 'present-value maximization' or 'internal rate of return' calculation in project selection to be 'based on assumptions rarely fulfilled in an actual planning situation. For such methods to be acceptable the price system must correspond to relative scarcities (defined with respect to an "objective function") and a suitable "time-rate of discount" must be accepted. Such information is almost invariably lacking in actual decision-making.' For this reason Bhaduri based his own argument on 'a more rough-and-ready method . . . used by Professors Kalecki and Rakowski, which was later embodied almost entirely in the official instruction on project-selection in Poland' (A. Bhaduri, 'An Aspect of Project-Selection: Durability vs Construction Period', *Economic Journal*, 78/2, 1968, p. 344).

Research into the methodology used in Poland to evaluate the efficiency of investment was also undertaken by D. M. Nuti who in 1964 wrote a paper on the 'Recoupment Period and Investment Criteria in the Socialist Economies' (its parts were later incorporated into is his Ph.D. thesis on the 'Problems of Investment Planning in Socialist Economies', University of Cambridge, 1970; see also his article 'The Evolution of Investment Planning in Poland', *Jahrbuch der Wirtschaft Osteuropas*, 3/3, 1971). With respect to Nuti's interpretation of some elements of the paper by Kalecki and Rakowski and of *The General Instruction* of 1962, Kalecki wrote to Nuti in a letter of 18 Apr. 1967:

Dear Mr Nuti,

I sent in the last days of January a positive opinion on your qualifications to the Appointments Committee and I received a confirmation of its receipt. I hope that you got the job.

On this occasion I studied your paper 'Recoupment Period and Investment Criteria in the Socialist Economies'. Although my general opinion of the paper is favourable (as I stated in my note for the Appointments Committee), I have a number of comments and I should like to communicate to you the most important ones.

1. Let me start from the end of p. 50 and say that you completely misread the meaning of the life-span of equipment n. In the Polish *Instruction* (and in the paper by Rakowski and myself) n *does* allow for obsolescence. This is easily seen from pp. 86–9 of the *Instruction* where it is made clear that n is *not* a durability norm, but that the life-span is determined at the optimum level corresponding to the relation between investment I and current cost K of a given variant.

2. With reference to pp. 36 and 37, it is clear that we considered in the paper in question the recoupment period T as the tool for balancing the supply of labour for new plant with the demand for it. When we say that $T = 6$ years on the basis of the existence of many opportunities of cheap modernization and mechanization, we are quite conscious that this is but the first approximation. It really means that with a large stock of opportunities of this kind we are unlikely to run into a labour shortage and we anticipate further enquiries which might have led to the shortening of the recoupment period. The concept of the recoupment period is more precisely presented in my essay on the production curve which you also quote in your paper but in another context.

3. Your argument on pp. 33 and 34 on scrapping of old equipment does not take into account that this equipment, if not scrapped at a given time, would not exist as long as new equipment so that the problem of the different life-spans which you consider in your section X arises here. In the *Instruction* this problem is treated accordingly.

4. I have some doubts with regard to your argument on p. 44 concerning q_z. If T has been determined by supply of and demand for labour, it seems to me that q_z may differ from $1/T$ because T, as you use it in your argument, is that T which would ensue provided you had actually carried out 'defreezing'.

5. You use everywhere in your paper a continuous production curve, not only for the economy as a whole (as I do in my essay

on the curve of production), but also for the single commodity groups which is not warranted by the facts because only a few variants may be available.

With best regards

Yours sincerely
[M. Kalecki]

(Copy of the letter is in Kalecki's files; see also his article 'The Curve of Production and the Evaluation of the Efficiency of Investment in a Socialist Economy', this volume.)

Many years later Nuti returned to his differences with Kalecki on the latter's implied use of the rate of interest. Noting that the marginal recoupment period T implied a definite rate of interest, Nuti again raised the question why the locking up of investment resources in the form of a longer gestation period should be treated any differently from locking up investment resources in the form of a higher investment intensity.

When I put this question to Michał Kalecki he insisted that $1/T$ and q were different concepts and could differ; the only way I could accept this was by looking at them respectively as linked to notional long-term and short-term interest rates. Kalecki insisted that their near-identity was a mere coincidence, but seeing that they were so close he saw no point in discussing the question further. (D. M. Nuti, 'Michał Kalecki's Contribution', p. 344.)

Next Nuti points at the third rate of interest implied in Kalecki and Rakowski's treatment of plant durability, and concludes that in their approach:

no less than *three* shadow rates were introduced, implicit in T, q, and in the use of g to calculate I_n and Z_n. Shadow rates were fairly close (15.7% for T, 15% for q, 7–15% for g) but the approach was untidy and messy. Why did Kalecki become so involved in it? Presumably the answer is that he would have liked to introduce an actual interest rate in investment selection . . . but was operating within the system dominated by a Soviet practice (that of recoupment period) difficult to change; he also specifically did not want to introduce interest and profitability in the selection of areas of capacity expansion . . . ; at the same time he wanted to improve the existing planning system, practice prevailing over theory in his concern. (Ibid., p. 346; see also p. 328 below.)

[2]
A correction is made here in the original formulation by Kalecki and Rakowski which was as follows: 'The advantage would be highest in the case of $a = 0$, i.e. in the case of simple reproduction. Then $Z_n = n/n_s$. For $a = 0$, however, the fraction: $\{1 - [1/(1+a)]^n\}/\{ - [(1+a)]^{n_s}\}$ is undefined.

A Rejoinder to Mr A. Święcicki

[1]
Published as 'W odpowiedzi A. Święcickiemu', *Ekonomista*, 54/5, 1961, pp. 1173–7. The publisher's permission to reproduce this article is gratefully acknowledged.

The solution proposed by Kalecki and Rakowski in their 'Generalized Formula of the Efficiency of Investment', and also in *The General Instruction* of 1960, was original and ingenious. It seemed also theoretically appropriate to the centrally planned economy. Yet their approach to the durability period of capital equipment from the very beginning inspired many doubts, and not just because of misapprehensions about it. The Kalecki and Rakowski method encouraged additional investment outlay that merely lengthened the life-span of plants. This seemed incomprehensible when, arguably, these resources could have brought greater benefits applied elsewhere. Although this deficiency was pointed out, its cause was still undefined. It was suggested that it might have been due to the fact that the individual parameters of the Kalecki and Rakowski formula were derived separately and then successively incorporated into it, without allowing for their reciprocal action (see Cezary Józefiak, 'Polemically about Investment Efficiency Calculation', *Życie Gospodarcze*, 15/4, 1960 (in Polish)). Other critics, A. Święcicki among them, argued that if two alternative investment projects differed from each other only in their life-span, then the project with a longer life-span, implying lower depreciation per unit of output, should be selected (see A. Święcicki, 'On the Generalized Formula of the Efficiency of Investment'). Appreciating the advantages of long durability of a plant, these critics failed to take into account moral depreciation of capital—the greater, the longer the life-span of equipment.

Although Święcicki's argument contained a serious error which was severely criticized by Kalecki, it should be noticed that the author of this error was also close to the idea that, given the values of the other variables concerned, the investment efficiency formula reaches a minimum value only for a given production life-span. This was in fact the key idea behind the new solution proposed shortly after this exchange of views by Rakowski. It consisted of deriving the optimum plant durability period from the formula of investment efficiency itself; for this optimum durability period the formula reached its minimum value (see Miczysław Rakowski, 'The Durability Period in the Investment Efficiency Formula', *Gospodarka Planowa*, 16/10, 1961 (in Polish)). In fact, it is to this article, and not to the *Generalized Formula*, that Kalecki made reference in his 1962 paper on the 'Efficiency of an Investment Programme' (see this volume); this solution was then incorporated in *The General Instruction* of 1962.

Many of these misapprehensions and disputes could probably have been avoided, had it been realized that, in the final analysis, there was not just one issue, but two. Having rejected the golden-rule discount method, Kalecki and Rakowski rightly concentrated on the problem of setting a rate of interest (or a normative recoupment period). But regardless of this, there is the problem of the accounting method used to make the inputs and outputs of various production methods commensurable once the discount rate has been fixed in one way or another. With different plant durability periods and different time-profiles of inputs and outputs corresponding to the alternative methods of production, the discounting method is superior. It is also simpler to use than the method proposed in the successive versions of the Kalecki and Rakowski approach.

The method used by Kalecki and Rakowski was criticized along similar lines to those of A. Święcicki by Bronisław Minc who wrote:

> There is no theoretical ground to assume a standard plant durability period for investment projects equal to twenty years throughout the national economy (on the contrary, these periods vary in different industries). There is also no ground for adjustment of investment efficiency coefficients for plants of non-standard durability periods, or for production cost through special discount rates. ('The Economic Efficiency of Investment in a Socialist Economy' *Ekonomista*, 54/3, 1961, p. 525 (in Polish)).

Minc also argued that the rate of discount had to be set arbitrarily, and suggested his own method of calculating the efficiency of investment. It consisted of comparing the 'annual outlay', i.e. the sum of total investment outlay and operating costs in a given production process, divided by the life-span of this process. This method also favoured processes with long durability of equipment, forgoing moral obsolescence of capital. Moreover, it neglected altogether the problem of choice between investment outlay and labour, which in Kalecki's approach was precisely the key criterion of choice of investment projects. However, while Minc's approach was rather geared to determining the 'absolute efficiency' of a given investment project, Kalecki considered the search for the absolute efficiency as methodologically erroneous in a centrally planned economy, and proposed instead to concentrate on the 'relative efficiency' based on alternative variant, of capital and labour producing the same use-value.

Efficiency of an Investment Programme

[1]
This article appeared as 'Efektywność "programu" inwestycyjnego', *Gospodarka Planowa*, 17/3, 1962, pp. 9–12. The publisher's permission to reproduce it is gratefully acknowledged.

In the annual report on his research in 1960, Kalecki among other things wrote:

At present I continue my work on the efficiency of investment. An attempt at a general theory of this problem was put forward in my article written jointly with M. Rakowski. . . . We now work on the issue of efficiency of modernization in old plants. (Kalecki's files.)

Another extension of this theory was his attempt to apply it to the appraisal of the investment efficiency of industrial development programmes ('investment programmes'). This was brought about by the need to establish criteria for assessing the efficiency of long-term programmes of investment in different sectors of the economy. (In his later works on the theory of economic efficiency of investment Kalecki made no reference to this attempt.) Also, in the Planning Commission Kalecki continued to supervise studies on economic efficiency of various investment and foreign trade projects (see e.g. Record No. 29 from the session of the Planning Commission's Board of 2 May 1961, AKPRM, ref. no. 54/113).

The outcome of all these activities was the drawing up, in 1962, of draft regulations on methods of appraising the economic efficiency of investment. This draft completed and expanded (especially in the area of modernization and small-scale investment) *The General Instruction* that had been used in investment planning in Poland since 1960. On 2 Apr. 1962 the draft was discussed by the Planning Commission's Board. In the course of discussion Kalecki outlined the most important changes put forward in the new guide-lines. He also pointed out that one of its aims was to induce investors to undertake more modernization schemes, to reduce the preference for capital-intensive works, and thereby to save on investment resources. Following the discussion, the new instruction was officially approved (see Record No. 26, AKPRM, ref. no. 75/105).

Compared to *The General Instruction* of 1960, its 1962 version modified some of the parameters of investment efficiency calculation as well as the synthetic formula of the efficiency of investment. The problem of adapting this formula to the analysis of special cases (completion of new investment by stages, expansion of the already existing plants, international specialization, and so on) was also solved differently. Together with the new *General Instruction*, another manual, the *Guidelines on Efficiency of Small Investment Projects, and Organizational and Technical Undertakings (especially related to the Enhancement of Technical Progress, Export-Orientated or Import-Substitution Production)* was published. It included, among others things, simplified methods recommended for the analysis of small investment projects.

The issuing of the new instructions for investment appraisal was accompanied, as with their earlier versions, by the publication (in 1963) of a revised and extended set of studies in the theory and practice of investment efficiency calculations (for the book's English translation, see M. Rakowski (ed.), *Efficiency of Investment in a Socialist Economy*, Warsaw, PWE, 1966). Besides examining the theoretical and methodological foundations of *The General Instruction*, and providing examples of the practical application of methods adapted for the analysis of investment efficiency in more important sectors of the economy, the book also dealt with some problems not covered by *The General Instruction*. Kalecki's Preface to this book follows in Annex 6.

ANNEX 6
Preface[1]
[to *The Efficiency of Investment*]

The Efficiency of Investment can be regarded as a summing up of work done by the Economic Research Division of the Planning Commission at the Council of Ministers of the People's Republic of Poland on the theory of studies on the efficiency of investment and its applications. This work was to a great extent connected with the preparation of the new General Instruction on Methods of Studies of the Economic Efficiency of Investment published by the Planning Commission in 1962. The team which dealt with this problem in 1959–60 and which I headed included M. Rakowski, J. Czarnek, Z. Knyziak, and others; however, the main contribution to the concept presented in *The General Instruction* was made by M. Rakowski.

In view of my participation in bringing precision to these theories I am not in a position to comment on their value. I can only note that we have made an honest effort to attain at least the first approximation in solving the extremely complicated problem of comparing the efficiency of investments. I took no part in the writing of this book but I acquainted myself with its text and can say that it is of great educational value.

[1] *Efficiency of Investment in a Socialist Economy*, pp. ix–xi.

In this book the theory of studying the efficiency of investment is presented much more fully than in *The General Instruction* and in the theoretical commentary to this instruction. A characteristic feature of the theory can be seen clearly: the close connection between the efficiency of a given enterprise and the overall development of the national economy.

The authors wish to point out the approximate nature of the solutions and the possibility of different approaches, etc.; they frequently anticipate doubts which may arise in the minds of readers and provide answers for them.

The book is rather an account of a search than an ossified doctrine proclaimed *ex cathedra.* Attention should be drawn to the vital importance of examples which indicate how well thought out a study of the efficiency of investment must be even when an arsenal of formulae is available.

Apart from discussions closely connected with *The General Instruction* the book also contains several chapters expanding this subject. They are devoted to the efficiency of development in branches of production and services, and the efficiency of investment relating to trade and international co-operation. These chapters present formulations which are not yet of a completely 'official' character and which concern subjects less elaborated but undoubtedly equally interesting as those in *The General Instruction.* This makes it possible to map out the direction of further studies, the results of which it will be possible, at least in part, to incorporate in supplements to those instructions.

The question arises as to whether studies on the efficiency of investment are of practical importance, whether equivalent results can really be achieved in this way by means of much smaller outlays. This depends entirely on a number of different variants being submitted for every investment undertaking. This effort cannot, unfortunately, be replaced by any theory of the efficiency of investment. If such a task is not undertaken, the application of the theory becomes barren for there is no problem of choice where there is only one variant; for this problem is not important enough if all the variants are similar to each other. The examples submitted in the book permit the statement that calculation of the efficiency of investment can ensure considerable savings when production variants that differ sufficiently are taken into account.

In my opinion *The Efficiency of Investment* may be of interest not only to persons who deal with studies on the efficiency of investment by virtue of their profession, for it is in general a school of, what I call, 'variant thinking'. Whoever reads it and understands it, will surely accept the principle that nothing must be accepted uncritically but a study should be made to find which of many possible roads yields the greatest benefits in the development of socialist economy.

The formulae for calculating investment efficiency adopted in *The General Instruction* of 1960 and that of 1962 were not the only ones in Polish literature at that time. Besides the already mentioned method of 'annual outlays' there was also a method based on a rate of interest, discounting the flows of inputs and outputs for each investment project. While it left unsolved the problem of how to set the discount rate itself, it was much the same as the method of the 1962 *General Instruction* (see Henryk Fiszel, *The Efficiency of Investment and the Optimum Production in a Socialist Economy*, 2nd edn., Warsaw, KiW, 1963 (in Polish)).

Similar investment selection criteria were used in the 1960s in the other CMEA countries. Regulations about choosing between investment variants were usually based on the methods applied in the Soviet Union (see *Tipovaia Metodika Opriedielenya Ekonomitcheskoi Effiektivnosti Kapitalnyh Vlozheniy i Novoi Tiechniki v Narodnom Khoziastvie SSSR*, Moskva, Gosplan SSSR, 1960 and *Metodika Opriedielenya Ekonomitcheskoi Effiektivnosti Vniedrieniya Novoi Tiechniki, Mechanizacji i Avtomatizacji Processov v Promyshlennosti*, Moskva, Gosplan SSSR, 1962).

Only in Poland and Hungary did investment regulations depart significantly from the Soviet method by introducing a uniform recoupment period or target rate of return in place of recoupment periods differentiated by industry.

An important weakness of the method used by the Planning Commission, which was not eliminated in subsequent years, and which it shared with other methods of calculation proposed at that time, was that it was insufficiently comprehensive. With the current state of economic knowledge and techniques of calculation, it was impossible to perform a calculation which would account for all interdependencies throughout the economy. That is why the calculation stopped at partial optimization which, it was believed, approached an overall economic optimum, and which was undoubtedly an improvement on using hardly any calculation at all. There was also the problem of the reliability of the information necessary to calculate the efficiency coefficient of each investment project and, associated with the estimation of the project's cost, the problem of devising a sufficiently large number of alternative projects. Then there was the problem of the faulty price system underlying all these calculations, and so on. All these considerations made Kalecki treat the results of these calculations with much scepticism.

After leaving the Planning Commission in 1964 Kalecki's work on the theory of investment efficiency calculations was increasingly loosely linked to current needs for drawing up new regulations and instructions on the practical choice of investment variants. He was more concerned with theoretical issues, such as the basis for optimizing different variants of the structure of consumption, improved methods of accounting for differences in the time-profiles of inputs and outputs in alternative investment variants, and the link between the theory of efficiency of investment and the theory of growth in a socialist economy.

The above-mentioned convergence of the methods used in comparing the economic efficiency of investment among the CMEA countries inclined the Economic Commission of the CMEA to regard the results of these calculations as a basis for international division of labour among socialist countries. Kalecki, who from the autumn of 1959 onwards, argued at many meetings of the CMEA Economic Commission for the co-ordination of the perspective plans for economic development in these countries (see *Collected Works*, vol. iii, pp. 401–5), hoped that the results of investment efficiency calculations, carried out according to their respective methodologies in each of the CMEA countries, might be an important step towards such a co-ordination. Thus he supported this initiative, albeit with three important qualifications.

The first referred to the methodology of calculation of investment efficiency. In the CMEA Economic Commission and in its special working party set up to look at the issue, the view prevailed that first of all fundamental theoretical research on the methodology of investment efficiency calculation should be conducted. Only after having arrived at a uniform methodology, should it be applied in international comparisons of specific investment undertakings.

Kalecki regarded this approach as mistaken. He proposed instead a compromise solution under which the Soviet methodology and the standard recoupment periods proposed by the Soviet delegation should be provisionally accepted, without going into their theoretical justification (indicating only that the methodology used in some countries differed from the Soviet one). He feared that attempts to achieve theoretical consistency and uniformity between countries would only lead to protracted academic discussions about subjects on which there were significant differences of opinion, not only among individual countries, but within them as well, notably in the Soviet Union. The CMEA Economic Commission did not seem to him to be a suitable forum for such discussions. He thought the objective of the Commission was not to strive for a uniform theoretical position, but to formulate some standard methods of calculation of investment efficiency that could be used in practice. Moreover, Kalecki was aware that efforts to arrive at such uniformity almost certainly would have delayed work on the actual international comparisons that were the underlying purpose of the whole enterprise, and the basis of the long-term programme of specialization. (See Report of the Polish Delegation to the VIth Meeting of the CMEA Economic Commission in Warsaw, 19–20 Oct. 1961, AKPRM, ref. no. 301/9. Although Kalecki managed to push through his position at the October 1961 session of the CMEA Economic Commission, later on his ideas got bogged down in serious difficulties; see ibid. and AKPRM, ref. no. 301/12.)

The second qualification concerned the methods used to calculate the efficiency of investment advocated in the standard methodology. Two general methods were recommended: the 'stage efficiency' method, and the 'cumulative efficiency' method. Kalecki considered them both to be wrong.

According to the first method, all inputs of materials were calculated at prices of the country whose money was used as the standard, i.e. at Soviet prices. This was reasonable since the calculation of efficiency was meant to apply to a given phase of production. (For instance, when considering a project for a machine-building factory there was no need to be concerned with the efficiency of steel production since this could be imported if necessary.) However, in the case of materials which could not be traded on international markets, or whose transportation cost was high, this method was clearly deficient and had to be supplemented by the second method.

The second method consisted of calculating the material inputs and the value of investment at their production cost. This too could not be applied in all cases. Where costs of transport were insignificant, the efficiency of investment should not be calculated according to it since machines and material inputs needed for the operation of a particular plant could be imported. If, for instance, in some country the cost of producing textile machinery was very high, then the calculation of investment efficiency should not point to this country's textile industry as being inefficient. The question of inefficient production of textile machinery should be reflected in the division of labour within the engineering industry, and not in the appraisal of profitability of the country's textile industry. If a country produced expensive cotton, it would not follow that it should not develop its textile industry, and that it should be developed in countries which do not produce cotton at all. At the most, this calculation should perhaps result in a conclusion that cotton should not be produced in this country; however, even then, as Kalecki pointed out, the situation in this country's balance of payments might alter this conclusion. In his opinion, the method of 'cumulative efficiency' should therefore be applied only to goods needed either during the construction of a given plant or when it was operating, and for goods which are not internationally traded and without high transportation costs.

Moreover, according to Kalecki, the approach of the proposed methodology to the problem of efficiency of combined investment projects was incorrect because of inconsistencies in the calculation of material costs. When the second method was adopted then a country's combined investments over a given period should be taken into account. When the first method was used then the outlay on all investments should be calculated at the prices of the country in whose money all prices were expressed.

The third of Kalecki's reservations concerned the use of investment efficiency calculations as the basis for deciding the division of labour among the CMEA countries. He wrote:

> It may be expected that cross-country comparisons of the efficiency of a given investment project would only play an insignificant role. For even if a particular country was found to be less efficient than other countries in all spheres of investment activity, no one would think about stopping its development.
>
> For instance, a comparison as to efficiency in constructing power plants shows, that it is low in the GDR and high in Czechoslovakia, while Poland and the USSR take an intermediate position. To say nothing of shortcomings in the method of calculation . . . no conclusion can be drawn from this comparison. It should not be suggested therefore that the GDR should stop the construction of its power plants based on lignite deposits and instead import electricity from abroad. Thus, for the time being it would be wise not to come to any final conclusions on the future application of efficiency coefficients. (AKPRM, ref. no. 301/12.)

At the same time, in all these debates Kalecki insisted that international specialization should in principle not affect the balance of trade of any partner.

The above debates did not lead to the adoption of any standard methodology for investment efficiency calculation and ended, as was already mentioned, in a stalemate which lasted until the end of the CMEA Economic Commission's existence in 1971.

The Problem of the Optimum Structure of Consumption

[1]

This paper was read by Kalecki at a conference held at the Main School of Planning and Statistics in 1963, and first published as 'Zagadnienie optymalnej struktury spożycia', *Gospodarka Planowa*, 18/7, 1963, pp. 3–7.

The Russian translation, 'Problemy optimalnoi struktury potriebleniya' was published in *Ekonomika i Matematicheskiye Metody*, 1/1, 1965, pp. 54–61. The English translation, 'The Problem of the Optimum Structure of Consumption' appeared in *Mathematical Studies in Economics and Statistics in the USSR and Eastern Europe: A Journal of Translations*, 1/4, 1965, pp. 3–16. The Hungarian translation, 'Az optimális fogyasztási szerkezet problémája' was published in M. Kalecki, *A szocialista gazdaság működéséről: válogatott tanulmányok 1956–1970*, pp. 99–113.

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Since the late 1950s Kalecki had been pointing to the need for including in calculations of investment efficiency the problems of the choice of the structure of consumption (see his letter to Stanisław Braun, of 20 Aug. 1960, p. 297–8, this volume). The debate on the 1961–5 Five-Year Plan, and the 1961–75 Perspective Plan, in the course of which there occasionally appeared some risky propositions concerning the optimization of the consumption structure (as illustrated by the example quoted in the first paragraph of Kalecki's article) caused him to look at this problem more systematically. Part of the research on the optimum structure of consumption was conducted under the auspices of the Research Committee on Social Issues in People's Poland, at the Polish Academy of Sciences (see Kalecki's reports on the activities of this Committee in 1963 and in subsequent years, copies of which are in Kalecki's files; see also pp. 338–43, this volume).

After this article was published in Poland, Kalecki sent its English translation to I. M. D. Little (no copy of the accompanying letter survived in Kalecki's papers). In his reply of 5 Mar. 1964, Little wrote:

Dear Kalecki,

I am sorry that I have kept your article so long before reading it, but at least I warned you that this was likely to happen.

You asked me whether I thought there was any point in seeking to get it published in England. It is mainly devoted to arriving at well-known results in ways that are likely to be more acceptable in Poland than the conventional Western approaches to the same conclusions. My feeling is that most readers here would not find this tremendously interesting. Also, I think your derivation of what is, in fact, an 'indifference' curve, is probably identical with that of Samuelson in 'The Consumption Theory in Terms of Revealed Preferences', *Economica*, 1948.

But, of course, this is only my view. If you feel you would like to submit it to any journal, I do not think you should take my view as being the last word.

Yours sincerely,
[signed: Ian Little]

(The letter is in Kalecki's files. Professor I. M. D. Little's permission to reproduce it is gratefully acknowledged.)

Kalecki's concept of the 'curve of equivalent consumption bundles' is also methodologically akin to D. G. Champernowne's concept of the 'chain index of capital' (see his 'The Production Function and the Theory of Capital, a Comment', *Review of Economic Studies*, 21/2, 1953–4; see also G. C. Harcourt, *Some Cambridge Controversies in the Theory of Capital*, Cambridge, CUP, 1972, pp. 29–34).

In the indifference curve concept of welfare economics, the subjective preferences of consumers and their optimizing behaviour determine the equivalence of consumer-goods baskets which therefore may be very different in their structure. The equality of the price ratios and the marginal quantity ratios, $dx/dy = -dp_x/dp_y$ in the standard notation, follows from consumers' choices. In Kalecki's concept of the 'curve of equivalent consumption baskets', on the other hand, it is the central planner who decides on the equivalence of different baskets, and it is the equality of the price ratios and the quantity ratios which makes them equivalent. (Both these concepts may be traced to the Labour Theory of Value, according to which in equilibrium market-clearing prices are equal to 'prices of production'. Incidentally, in calculating costs of production Kalecki used in this context the simplified formula for calculating the efficiency of investment.) To satisfy his condition of equivalence Kalecki needed only minor and counterbalancing differences in the composition of the baskets compared. Keeping to the principle of making small and counterbalancing changes across the whole range of goods (which justified neglecting as insignificant changes in relative prices resulting from alterations in the composition of baskets), Kalecki obtained a chain index of equivalent consumption structures. The curve thereby derived was concave.

Both the welfare economics' approach and Kalecki's suffer from some well-known theoretical weaknesses. However, the solution proposed by Kalecki has an additional drawback as well (which also applies to his ideas on the choice of alternative investment projects, see p. 333 below). His approach does indeed take into account the interdependencies between the physical composition of consumer output and market prices, but there is a third variable which interacts with the other two. This is the rate of interest (conceptually equivalent here to the rate of discount, or the normative recoupment period used in the calculation of investment efficiency). In Kalecki's argument, the starting-point is the rate of interest that has been set, and which influences the long-run costs. Given these costs, one arrives at a structure of production in which (taking into account the price elasticity of demand) price ratios are equal to long-term cost ratios. There is therefore a definite procedure followed through.

This procedure, however, is open to criticism. The rate of interest itself depends on the composition of the final output to be produced. But we must choose this rate in advance, since without it the long-term costs cannot be determined. Only subsequently can we find that structure of production whose price ratios are equal to its cost ratios. But the composition of production thereby arrived at may be different from that used to determine the rate of interest. In other words, there may be a different rate of interest appropriate to the final composition of output. If so, then the long-term cost ratios need to be changed and a new structure of production with its corresponding price ratios must be sought. It is uncertain, however, whether a repetition of this procedure would bring us closer to a solution; the 'capital controversies' suggest that even small changes in the structure of production can give rise to large changes in relative prices, and vice versa, and that monotonic changes in interest rates may be associated with non-monotonic changes in relative prices. In the light of these debates, convergence does not seem a likely possibility.

The practical significance of this problem is not obvious. Kalecki's approach would suggest that it is not great. However, it is not clear whether he ever reflected on precisely this issue, although he wrote in this paper also of the need to resolve many issues *before* computers can choose for us the best consumption variant.

In 1964 the English translation of Kalecki's article was discussed in the Department of Planning of India's Statistical Office (see the letter of S. M. Knasal to M. Kalecki, of 29 Dec. 1964, and the comments of T. N. Srinivasan, and Kalecki's reply of 18 Jan. 1965; all in Kalecki's files).

The Curve of Production and the Evaluation of the Efficiency of Investment in a Socialist Economy

[1]

This article first appeared as 'Krzywa produkcji a rachunek efektywności inwestycji', *Ekonomista*, 58/1, 1965, pp. 3–14.

Its Russian translation, 'Krivaya proizvodstva i rastchot effiektivnosti kapitalovlozheniy', first appeared in *Ekonomika i Matematicheskiye Metody*, 2/4, 1966, pp. 510–19, and then as 'Krivaya proizvodstva i tieoria effiektivnosti kapitalovlozheniy', in *Tiempy i proporcyi socyalistitcheskogo vosproizvodstva*, Moskva, Statistika, 1968, pp. 116–27. The English translation, 'The Curve of Production and the Evaluation of the Efficiency of Investment in a Socialist Economy', appeared in C. H. Feinstein (ed.), *Socialism, Capitalism and Economic Growth: Essays presented to Maurice Dobb*, Cambridge, CUP, 1967, pp. 87–100. The French translation, 'Courbe de production et calcul d'efficacité des investissements' was published in *Économies et Sociétés*, 4/1, 1970. For information on parts of this article incorporated in the Appendix to the *Introduction to the Theory of Growth in a Socialist Economy*, see p. 286, this volume.

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Prior to publication, the article was presented to the Conference of Political Economy Chairs, in Sept. 1964, at Zakopane. The discussion was introduced by Kalecki's 'Theses on Technical Progress and its Types', which follows below in Annex 7.

ANNEX 7

Theses on Technical Progress and Its Types[1]

1. An increment in the national income, whose volume and structure are given, can be produced through different combinations of investment outlay and labour. If investment inputs are plotted as the abscissa, and labour inputs as the ordinate, then to each combination of these two factors there corresponds a single point. Let us discard all combinations for which the input of one factor is greater while that of the other is not smaller. Points corresponding to combinations which survived this selection lie on a falling curve which we call the production curve.

[1] First published as 'Uwagi o postępie technicznym i jego typach (tezy)', *Zeszyty Naukowe Uniwersytetu Łódzkiego*, 1965, 10/III/10, pp. 5–6.

2. Construction of a specific curve of production can be represented as follows. In order to choose from among alternative variants of producing a given good, we first determine a given recoupment period T, the same for all branches of the economy. Then we select for every good produced the variant for which the commensurable total inputs, or the respective sums $(1/T)I + C$, are the smallest. It may be shown that the sum of investment outlay and labour inputs for all the chosen variants must be represented by a point on the production curve; that is the chosen variant for producing a given increment in the national income does not include any combination of investment outlay and labour that would be absolutely inferior to some other combination. Gradually changing the recoupment time T we arrive at a production curve.

3. Moving to the right along this curve, we increase the capital–output ratio of national income increment m and the recoupment period T, and decrease the inputs of labour in new plants, that is we increase the productivity of labour there.

4. Technical progress is reflected in a continuous downward shift of the production curve. This allows for a continuous growth in labour productivity without increases in the capital–output ratio. An additional increment in labour productivity can be attained through simultaneously moving to the right of the production curve. However, this additional increment in labour productivity requires an increase in the capital–output ratio.

5. If the production curve shifts downwards in such a manner that all its ordinate values fall in the same proportion, then this type of technical progress can be described as neutral. The annual growth in the productivity of labour (in new plants) in this case does not depend on the capital–output ratio m. If the rate of growth of labour productivity is higher, the higher is m, i.e. when the values of the abscissa decrease faster for the higher values of the ordinate, then such type of technical progress can be described as 'encouraging capital intensity'. In this case, moving to the right along the production curve produces not only a single increment in labour productivity in the new plants, but also increases the rate of growth of this productivity at a newly given capital–output ratio. Finally, if the rate of growth of labour

productivity is the lower, the greater is the value of m, then this type of technical progress can be described as 'discouraging capital intensity'.

6. The prevailing type of technical progress does not predetermine actual changes in the capital–output ratio. Under neutral technical progress capital intensity may increase if we move to the right of the production curve. With technical progress encouraging capital intensity, m can nevertheless remain unchanged, although with this type of technical progress it is easier, *ceteris paribus*, to decide to increase the capital intensity of output since this would lead not only to higher levels of labour productivity (in new plants), but also to a higher rate of its growth.

Kalecki's introductory 'Theses' were followed by a paper by Kazimierz Łaski, 'Temporary Deceleration of Growth and the Dynamics of Consumption in a Socialist Economy'. Then, in the discussion Kalecki said among other things:

In the extreme case of an awl, it becomes necessary to turn to more capital-intensive techniques of production if any progress in the productivity of labour is to be made at all. In this case transition to machine production means technical progress not because the awl is not very capital-intensive, but because it can hardly be improved. Using the awl we are condemned for ever to the same productivity of labour. In order to make any productivity gains we must turn from the awl to the machine. This explains why moving along the curve is crucial to technical progress.

If every increase in the productivity of labour is regarded as technical progress, then we may soon be making a wrong kind of judgement. For instance, in Poland we have had a demographic boom and we will have to opt for more labour-intensive and less capital-intensive investment projects. This will not be a retardation; nevertheless the rise in the productivity of labour will be slower than it would have been if the investment variants had been selected according to a different instruction. Moreover, technical progress by no means needs to result in reducing the inputs of only one factor. Indeed, it may lead to lower inputs of other factors of production as well. For instance, there are new inventions which focus only on capital intensity and in which the cost of casing and housing is being cut down. Such technical

progress has nothing to do with a reduction in the inputs of labour. It only reduces the capital intensity of output.

The transition from the awl to the machine represents technical progress which particularly encourages capital-intensive techniques since the use of methods of production which are based on an awl, a hammer, or a shovel, hardly leaves any room for new inventions and in this case technical progress implies a shift along the production curve; without it there would be no rise in the productivity of labour. In some cases, however, this argument may be of only limited applicability. One can use primitive machines for which technical improvements may theoretically be possible, but the application of such solutions to some less advanced socialist countries has attracted little consideration. It is therefore difficult to say anything more specific on this subject, especially as the examples of improvements made in primitive machinery are not very numerous.

The ratio of economies in the inputs of direct labour to inputs of capital is taken into account in the procedure of construction of the production curve through the marginal recoupment period T. The recoupment period represents the ratio of additional capital inputs to economies in direct labour.

On the other hand, there is no point in comparing the recoupment period and capital inputs over time (instead of comparing them for any two already existing investment variants), since in that case technical progress enters the scene and the recoupment period can take a negative value. The calculation of recoupment periods does not make sense when the production curve shifts downwards and the capital–output ratio remains unchanged, since in this case the recoupment period is equal to zero, that is, labour productivity rises with unchanged capital intensity of production.

The ratio of capital inputs to savings of direct labour inputs is a typically static concept which serves to derive the production curve. If we want to go for more capital-intensive equipment, then we must lengthen the recoupment period imposed by our investment instructions and, contrariwise, we must shorten it when we decide to go for less capital-intensive techniques. This does not need to be done only when economic calculation [of the efficiency of investment] has not been yet applied, and its very introduction can lead to important economies in the capital intensity of production through selection of less capital-intensive projects. However, since we assume that such calculations have been made for every investment project, then in order to move on to another capital–output ratio we have to change the recoupment period.

Taking into account conditions of work, safety, etc., calls for introducing a new parameter which never previously entered our formula. Of course, the purpose of increasing the capital–output ratio may be to eliminate some unsafe or particularly hard labour. This, however, is not taken into account in the evaluation of efficiency of investment variants since these additional capital outlays do not follow from our optimizing procedures but from wholly different premisses. . . . When projecting a plant, we have to know what capital–output ratio is needed to make some given savings on labour inputs; however, for all alternative projects we must also determine in advance specific restrictions and reject those projects which require tedious labour or fail to meet safety regulations.

If we plan to reduce work hazards and to eliminate tedious types of labour, this must be binding on all investment projects. Then a minimum requirement has to be met by every variant and we do not need to consider this requirement separately when examining the efficiency of investment projects. True, there can be certain differences, for instance the plan's targets may be better met in the case of one variant rather than another, but in principle the requirements of the plan simply have to be met by all variants.

The recoupment period should not depend on particular work hazards in a given industry since in every investment variant these would be more or less the same and the differences would not be reflected in the respective capital–output ratios. Indeed, it can be argued that this problem should not be taken into account in our calculations when possible economies in the inputs of labour are considered, since work safety is an end in itself. As other social facilities, this factor is independent of the selection of investment projects. It simply must feature in every investment variant.

Can the introduction of new types of equipment be represented on the same diagram if production factors in the $t+1$ period always differ since they represent the use of better quality machines and intermediate inputs, which is the basic precondition of growth in the productivity of labour? We assume that investment outlay is expressed at constant prices. If the cost of machines (at constant prices) is the same and their performance is better, this

would itself represent a smaller increase in capital intensity. These machines are better because at the same capital–output ratio the productivity of labour rises. Increased labour skills can also be included in technical progress provided that they are assumed not to alter the homogeneity of labour inputs.

Technical progress can be largely dependent on growth in labour intensity, but this is a different type of progress. Technical progress may be defined as making capital equipment more productive although it remains unchanged; the same workers, once they acquire more skills, become more productive. . . . If the same machine for the same output requires fewer inputs of labour, then it can be considered a better machine; if with the same capital–labour ratio the same labour is more productive, then the labour is more skilled. Using the same labour a higher productivity may then be achieved without increasing the capital–output ratio.

If, however, not the quality of production factors, but the quality of output changes, then the productive result, are not the same and we obtain an increment in a different national income. My argument rests on the assumption that moving along the same production curve always implies the same volume of output. We may agree that measuring changes in the quality of output is difficult. But if we know how to measure it, then our argument is still valid because with the same inputs of labour and investment we obtain a larger output, of a better quality. This would be the third case which is represented by movement along the production curve: from the same combination of factors of production we obtain a greater output since, expressed at constant prices, better means greater. However, we may not compare two wholly different products, such as a metre of crude linen and a metre of poplin. If with the same inputs poplin is manufactured where crude linen was produced before, then this is a technical revolution. (*Zeszyty Naukowe Uniwersytetu Łódzkiego*, pp. 24–8.)

In the course of discussion it was suggested that Kalecki's argument rested on the assumption that a rise in labour productivity must be accompanied by a rise in the capital–output ratio; therefore his argument was found to be applicable rather to past than to present conditions, when automation and industrial production of chips led to declining capital–output ratios. In reply Kalecki said:

Let us not go back to Robinson [Crusoe] and talk in such abstract terms. I do not see how such productivity can be had without investment outlay. If we want to start new production, we build a new plant. Why cannot we then say that these investment inputs and labour generate an increment in the national income? Without these inputs we may only speak of productivity of manual labour. This explains why investment inputs must accompany labour; the whole reasoning consists of showing how much of these inputs are needed to obtain a given level of productivity.

We can use the concept of a production curve—I have in mind the curve of a net rather than gross output—to explain also such technical progress which leads to growth in labour productivity and lesser capital intensity of production. In this case, technical progress will consist of a shift of the production curve. Nuclear power plants are a sign of progress when compared to conventional thermal ones. However, the former could not enter in the production curve until they were invented. Even if one had unlimited financial means, one could not build nuclear power plants when no one thought of them. Such progress does not contradict the idea of a downward-shifting curve of production. It is good that it shifts that way since it implies the discovery of new inventions, such as power plants of the future, in which both labour intensity and capital intensity of production will be less. (Ibid., pp. 28–9.)

In the debate there emerged the question of increasing national income through gains in the productivity of labour without additional investment outlay, that is, through the better use of the old plants. With reference to this question Kalecki explained:

My paper deals with an increase in national income which can be obtained through the construction of new plants, and not through productivity gains in the old ones. However, we could incorporate the old plants into our general formula. This would be an additional complication since there would then exist investment variants whose capital intensity would be equal to zero.

Fuller utilization of the old capacities is a slightly different question. It is nothing else than a choice of the least capital-intensive variant, except that there is no rise in the productivity of labour. Then this productivity of labour and zero investment outlay in the old plant are compared with the construction of a new plant which entails investment outlay but where the productivity of labour is also higher. It may then appear that fuller utilization of the old plant, although it can be considered obsolete, is a better deal, since it is better to use the already existing plant than to build a completely new one, even if the productivity of labour were much higher there.

Thus, the calculation of efficiency of different variants of producing an increment in the national income can also take into account growth in the productivity of labour both in the old and new plants. However, then this calculation loses its precision. The idea of a production curve refers to an increment in the national income obtained in new plants, which implies a different type of argument: it is assumed that it was decided to undertake investment, and the question is which investment variant should be chosen. It should be remembered that in our formula for determining of the rate of growth of national income there is a coefficient which represents improvements in the utilization of the old plants. (Ibid., p. 27–8.)

Then, in relation to the problem of discontinuity in the production curve, Kalecki said:

The use of the production curve for two variants only, as it is usually assumed in Western economics, is not correct. However, when combinations of all variants of producing an increment in the national income are taken into account, this renders a curve which refers to a large aggregate, and this makes it suitable for macro-economic analysis. The continuity of the curve stems from the fact that it represents aggregate categories, which gives it an advantage over a one-product curve.

The quoted example of shovels is extreme and one does not need to think of shovels when considering movements along the production curve. In some cases, not altogether exceptional ones, shovels are useful, but we should not go to extremes as there may be less striking differences, as in the case of choice between high and low mechanization. Let us suppose that some very modern machine was invented and put to work in the United States because American capitalists found it appropriate. We use a less modern machine. Does it follow that we must at all costs introduce the American machine and that all which is less modern is to be condemned? We have heard here some well-justified criticism of solutions proposed by the technicians. In the factories we often observe great disproportions in technical advance: high technology is demonstrated in the showrooms and, at the same time, sacks are carried on people's backs from one workshop to another. Just as economists have a weakness for calculation, technicians want to have the latest technical toys and we should not hold this against them, but we do not need to offer them these toys immediately. (Ibid., p. 35.)

In the course of debate Cezary Józefiak put forward a somewhat different approach to the determination of the marginal recoupment period T when the rate of investment is given and the available supply of labour is limited. There are different ways of allocating a given investment fund between the modernization of the old plants and the construction of new ones. Modernization of old plants increases their efficiency and thereby makes additional labour available for new plants. The effects obtained in this way would be large in the beginning, but would gradually decline as newer production plants underwent modernization. On this basis Józefiak constructed a curve of substitution between inputs on modernization of old plants and labour made available thereby for the new plants. Every point on this curve represented two effects: less investment outlay on new plants (due to increased outlay on modernization of the old ones), and a corresponding increase in the available labour.

According to Józefiak, such a programme of constructing new plants is realistic and the best available, and is represented by the point of tangency between the production curve and his curve of substitution between the modernization outlay and the additional labour made redundant in the old plants. This point corresponds to an equilibrium in the factor markets; it therefore also determines the optimum volume of national income and the desired level of the marginal recoupment period. (As long as the two curves intersect, it is profitable to expand modernization which shifts the curve of production upwards through increasing output. The slope of the point of tangency of the two curves determines the marginal recoupment time T. Of course, this optimum refers only to a given investment plan. See ibid., pp. 35–6.)

In the course of the debate Kalecki dismissed Józefiak's approach to the determination of the marginal recoupment period. (However, he later dropped some of his reservations, and encouraged Józefiak to publish his findings; see C. Józefiak, 'Production Curve and the Marginal Recoupment Period'.) Referring to Józefiak's ideas, and also to the paper of Łaski, Kalecki said:

If we want to switch the economy to a higher capital–output ratio we must introduce a longer T and allow the investment design bureaux to choose more capital–intensive projects. The opposite procedure must be followed if we want to reduce the capital–output ratio; then T must be reduced. Therefore, the relation between the subject of Professor Łaski's considerations and the recoupment period is as follows. If we decide to accelerate growth through gradual 'recasting' of fixed capital to a higher capital intensity, then we introduce a longer T which would be binding until further notice and which would promote the selection of more capital-intensive investment projects. When it is decided to 'recast' fixed capital to a lower capital–output ratio (in order to improve consumption), we make T shorter and apply it for some time.

A characteristic feature of these models is that once it has been decided to 'recast' the capital equipment to higher capital intensity, then investment will be more capital-intensive, for a return to a lower capital–output ratio would entail productivity losses. On the other hand, once capital equipment has been 'recast' to lower capital intensity, it will continue unless there is demographic pressure to change it. Since selection of investment variants largely depends on it, the recoupment period T is an instrument for guiding the economy towards one type of development or another. (Ibid., pp. 36–7.)

Closing the debate Kalecki said:

No coefficient of efficiency can solve the problem of social security, work safety, and so on. It does not follow, however, that we should refrain from calculating the efficiency of investment. But we should discard those variants which fail to meet the accepted standards of work conditions. The formula for efficiency of investment cannot by itself adversely affect work and safety conditions, etc., since the necessary precautions in this field must be included in every investment project. If some project stipulates additional investment to reduce work hazards, then this outlay should be calculated and included in the costs of the project. Any project which does not conform to acceptable work safety norms should be discarded altogether. It may well prove that another project, which does not involve equally dangerous types of work, is better, since it does not require additional outlay. If all investment design bureaux used this calculation, this would contribute to the choice of the best available methods of obtaining an increment in the national income at a given value of T.

Much of what was said in the debate had nothing to do with the formula for selection of investment variants. The formula is sound and it is the people, and not the formula, who should be held responsible for the end-results. Did the socialist countries not calculate the efficiency of investment, they would select capital-intensive investment projects and consumption would be low. If as a rule only a single investment variant is submitted, it means that the efficiency of investment is not calculated.

Furthermore, one must not confuse continuous curves, derived for an increment in the national income as a whole, with particular variants which relate to a specific product or process of production, of which one is selected at any given T on the basis of our formula for minimizing total outlay.

Total investment outlay, which is the sum of investment outlay of the selected variants, and which enables us to achieve a given increment in the national income, will be represented by some point in the plane of capital and labour intensity of output. This point will have a property such that any other combination of unselected investment variants would be represented by points the position of which will be worse. At a given T this first point is therefore the best. Increasing T, we allow more capital-intensive variants to be selected. Thereby we derive a curve which represents the best combination of investment outlay and labour inputs to produce a given increment in national income. The production curve is a set of points which represent optimum variants at given values of T. All this refers to an increment in the national income and has nothing to do with selection of the right point, lavish use of labour resources, and so on. The proof of this is set out in my paper.

The value of T depends on the assumed volume of the increment in national income and the available supply of labour. If with a given supply of labour we want to achieve a greater increment in national income, we must opt for higher labour productivity in new plants. We then choose a higher value of T and select more capital-intensive investment projects; over a period equal to the average life-span of capital stock they will be 'recast' to a higher capital intensity. During this period, say twenty years, there will be an additional growth of labour productivity due to this reconversion. This is on top of productivity gains resulting from the downward shift in the production curve under the impact of technical progress. Sometimes it may be beneficial to do the opposite, i.e. to 'recast' capital equipment to a lower capital intensity. In this case the rate of growth in labour productivity will be lower, but so will investment, and consumption will increase correspondingly. To achieve this we reduce T and 'recast' capital equipment to a lower capital–output ratio.

Thus, the choice of the point on the production curve depends not on some threshold values, but on the general strategy of the long-term plan—what time-path of consumption is to be achieved through 'recasting': is lower consumption in the short-run, but higher in the long-run the favoured strategy, or the opposite? In the extreme case mentioned by Professor Łaski, in which consumption is lower not only in the short but also in the long run, such a 'recasting' simply will not be carried out. If examined only from the viewpoint of the dynamics of national income and consumption, the decisions on the marginal recoupment period T, or the capital–output ratio m, are of a macro-economic nature and do not require any threshold values. They are simply instruments serving to reach given objectives. These objectives are decided by the authorities and must be kept within reasonable limits. If, for instance, we strive for a very high consumption level in twenty years' time, nevertheless we must not allow for a significant reduction in the dynamics of consumption over the next few years.

When constructing economic theories we try to explain what is actually happening, what are the consequences of decisions taken by those who, knowingly or unknowingly, run the whole economy. The purpose of the production curve concept is to demonstrate that such a curve indeed exists and that at every moment we are at some point on some production curve, provided investment design bureaux use our formula in calculating investment efficiency.

This justifies the incorporation of the production curve concept—independently of its practical application—in growth theory, and the use of this concept in explaining our policy measures—such as examining the effects of changing the capital–output ratio, or leaving it unchanged. The construction of the production curve helps to explain these effects. A theoretical concept used to explain what actually happens, but based on something which does not exist, would be erroneous.

The appropriate value of T is determined as follows. Initially we choose T arbitrarily, say, at its present level. Then we check how it fits with the planned increment in national income and with the available supply of labour. If we find that it corresponds to our objectives, we keep it; otherwise we have to look for a new T by trial and error. This would be the essence of the above mentioned 'game' with the investment design bureaux, although the 'game' itself would have to be simplified. However, macro-economic management through determining appropriate parameters must indeed consist of a mutual game with the investment design bureaux. A similar problem appears in the work on the optimization of foreign trade turnover, when attempts to determine a rational, marginal rate of exchange are made. (Ibid., pp. 43–4 and 47.)

Observations on Mieczysław Rakowski's Recent Approach to the Problem of Efficiency of Investment

[1]

First published as 'Uwagi o ostatnim podejściu M. Rakowskiego do problematyki efektywności inwestycji', *Gospodarka Planowa*, 22/7, 1967, pp. 15–17. The publisher's permission to reproduce this article is gratefully acknowledged.

For further comments and explanations by M. Rakowski, see his paper, 'The Efficiency Calculation and the Optimization of Economic Development', *Gospodarka Planowa*, 22/11, 1967 (in Polish).

Basic Problems in the Theory of the Efficiency of Investment

[1]

The article first appeared as 'Ob osnovnych problemach tieorii effiektivnosti kapitalovlozhenyi', *Ekonomika i Matematicheskiye Metody*, 6/5, 1970, pp. 683–94. The English translation, entitled 'Some Basic Problems in the Theory of Effectiveness of Capital Investment', was published in *Matekon: Translations of Russian and East European Mathematical Economics*, IASP, 7/4, 1971, pp. 349–69, and, later as 'Basic Problems in the Theory of the Efficiency of Investment', in M. Kalecki, *Selected Essays on the Economic Growth of the Socialist and the Mixed Economy*, pp. 124–44 (for translations of this collection, see p. 238, this volume). The

German translation, 'Die Hauptprobleme einer Theorie der Effektivitat der Investitionen', appeared in M. Kalecki, *Theorie des Wachstums und der Planung in der sozialistischen Volkswirtschaft*, pp. 133–50. The Hungarian translation, 'A beruházási hatékonyság elméletének alapvető problémái', appeared in M. Kalecki, *A szocialista gazdaság működéséről: válogatott tanulmányok 1956–1970*, pp. 73–98.

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In 1967 Kalecki wrote a paper 'On the Choice of Techniques in a Socialist Economy' which he contributed to a volume commemorating the 80th anniversary of an outstanding Polish mathematician Hugo Steinhaus (see *Zastosowania Matematyki*, 10, 1969, pp. 257–64; a short summary of Kalecki's paper appeared in *The Balances of the National Economy*, Warsaw, GUS, 1968, p. 165 (in Polish)). The first seven sections of the first part of the paper 'Basic Problems in the Theory of the Efficiency of Investment' are a revised version of Kalecki's paper of 1967; its important extension can be found in the last section of this part (where the problem of modernization of existing capital equipment is considered), and in pt. 2, on the 'Assessment of different variants of the expenditure on materials and of the role of foreign trade'.

The editor of the volume in honour of Hugo Steinhaus, Professor Jan Oderfeld, found Kalecki's model realistic and its mathematical solution correct and elegant (see Oderfeld's letter to Kalecki of 29 Sept. 1967; Kalecki's files).

A copy of the typescript of the 1967 article Kalecki sent to Nuti, who in reply of 12 June 1968 wrote:

Dear Professor Kalecki,

I spoke to Frank Hahn as soon as I was back, and I have now just heard from him, confidentially, that of course there should not be any trouble in changing the date of your visit, if you so wished. A formal decision will have to be taken by a College Committee in a few days, and you shall be hearing from Hahn in due course. I do hope you will decide to come soon: at the moment at our Faculty there seems to be some kind of silent (on not-so-silent) struggle—neo-Keynesian versus neoclassical economists, left versus right, with overlapping between the groups—and I am sure your presence could be most useful, and you would enjoy your stay.

I have read with great interest your paper on the choice of techniques under socialism. Unfortunately in my copy drawings are missing, and I am not sure whether I have been able to reconstruct them correctly. It would be helpful if you could let me have the missing drawings. I have only two minor points to make, both related to the notion of a and the process of scrapping:

1. You call the proportion of total output produced on currently scrapped machines, a, the 'coefficient of scrapping'. If a is kept (provisionally) constant, and the investment–output ratio i is taken as a variable, then the proportion of existing equipment scrapped (however this is measured) would vary with i even

if a was constant. Usually the opposite approach is followed, and a constant proportion of equipment is assumed to be scrapped, and in this case the proportion of total output produced on currently scrapped machines (your 'coefficient of scrapping') would vary with the value of i. I wonder what are the relative merits of the two approaches, but I am perfectly aware that this is not really a problem.

2. I presume investment in replacement will be carried out in the economy you are considering according to the rules to be found both in capitalist textbooks and in the *Instruction* of the Polish Planning Commission. Machines will be replaced up to the point where investment expenditure in replacement is recouped in a number of years equal to the standard recoupment period chosen for the purpose. In your symbols:

$$i_t/(x_t - c_t) = 1/\varepsilon$$

from which we have

$$xt = \varepsilon i_t + c_t$$

This is the same as the capitalist rule for replacement, under which full cost on new plant ($\varepsilon i_t + c_t$) should be equal to prime cost on the oldest plant in use, x_t. This equation would determine the scale of scrapping. If one accepts this rule, and I do not see at present why one should not, then the 'coefficient of scrapping' a is fully determined by past history as reflected by the structure of coexisting vintages, and by the speed and bias of technical progress (given the wage rate, the price of investment goods and the recoupment period). If this is correct, a cannot be taken as an arbitrary constant or as a policy variable, otherwise the system would become overdeterminate. The same problem occurred to me in my paper on the recoupment period, but there I take T as a variable and the coefficient of scrapping as an independent variable, so I do not think I am a variable short.

As I said these are only tentative comments, and I hope I will have the opportunity to discuss these points further, possibly after I have seen the missing drawings. I have sent you a copy of the final draft of my paper on the degree of monopoly in the Kaldor–Mirrlees model, and I would be delighted to have your comments.

(Kalecki's files; D. M. Nuti's permission to reproduce his correspondence with Kalecki is gratefully acknowledged.)

In his reply of 27 June 1968 Kalecki wrote:

Dear Mr Nuti,

Thank you very much for your letter of 12 June. I have received in the meantime an invitation from Churchill College to come whenever I like in the years 1968–69, 1969–70, or 1970–71, for at least one term up to a whole year. I have not yet decided when or for how long I would come.

I enclose the diagram which I forgot to append to my paper.

As to the points you make with regard to it, the coefficient a is really the same concept as in my theory of growth, and I think that this approach simplifies considerably the problem I deal with.

As to your second point, I disagree with your treatment of the 'replacement problem'. I criticized your approach already in my letter of 18 April 1967, commenting on your paper. I wrote there in my point 3: 'Your argument on pp. 33 and 34 on scrapping of old equipment does not take into account that this equipment, if not scrapped at a given time would not exist as long as new equipment, so that the problem of the different life-spans which you consider in your section X arises here. In the *Instruction* this problem is treated accordingly.' It is just this view upon the problem that led me finally to adopt a as an independent variable for a given branch.

I am still not ready to comment on your paper on the Kaldor–Mirrlees paper because I could not spare the time to study it thoroughly, but I hope to do it in the near future.

Yours sincerely,

(Unsigned MS dictated by Kalecki to his wife; Kalecki's files.)

In the summer of 1968 Kalecki spent two months in Cambridge as a Visiting Fellow of the Churchill College. At a seminar of Lord Richard Kahn, Kalecki gave a lecture on the choice of production techniques in a socialist economy. It was based largely on his paper 'Basic Problems in the Theory of the Efficiency of Investment'.

The Scope of the Evaluation of the Efficiency of Investment in a Socialist Economy

[1]

This note first appeared as 'Zakres zastosowania rachunku efektywności inwestycji w gospodarce socjalistycznej', in *Problems in the Theory of the Socialist Economy*, Warsaw, PWN, 1970, pp. 111–16 (a volume in honour of Professor Aleksy Wakar, who died in 1966 (in Polish)). It was later reprinted in *Gospodarka Planowa*, 26/5, 1971, pp. 270–1.

The English translation, 'The Scope of the Evaluation of the Efficiency of Investment in a Socialist Economy', was published in M. Kalecki, *Selected Essays on the Economic Growth of the Socialist and the Mixed Economy*, pp. 119–23 (for translations of this collection, see p. 238, this volume). Its German translation, 'Der Anwendungsbereich der Effektivitätsrechnung in der sozialistischen Wirtschaft' appeared in M. Kalecki, *Theorie des Wachstums und der Planung in der sozialistischen Volkswirtschaft*, pp. 129–32. The Hungarian translation entitled 'A beruházási hatékonyság értékelésének problematikája a szocialista gazdaságban' was published in M. Kalecki, *A szocialista gazdaság működéséről: válogatott tanulmányok 1956–1970*, pp. 67–72.

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At the end of the 1960s, partly in relation to the discussion in the European centrally planned economies on various projects of economic reform, which aimed at a widespread use of financial incentives and monetary categories related to profits and profitability of the enterprise, considerable criticism was made of the criteria for assessing investment efficiency. These criteria called for comparisons of combined outlay and costs per unit of output expressed in natural terms. However, this was at variance with the principle of conducting each calculation in value terms only. Furthermore, the criteria used in calculation of efficiency in the investment phase, different from those used for calculating the efficiency of the subsequent production phase, meant that economic calculation in the former was separated from that in the latter. Consequently, a new approach to economic calculation was eagerly searched for.

New principles for evaluation of investment projects were first introduced in Czechoslovakia in 1967. The methodology used up to that time, based on Soviet instructions, was replaced by calculation based on discounted flows of inputs and outputs in the whole production process, starting from first investment outlay right up to plant retirement. In Poland, the first changes were introduced in 1969. These covered calculation of investment efficiency not just in the choice of production methods, but also, albeit limited, in the field of enterprises' decisions concerning the composition of output (see 'Resolution No. 103 of the Council of Ministers of 7 June 1969, on Appraisal Methods and the Classification of Newly Commenced Industrial Investments in 1971–1975', in Polish, and *Regulations on Planning and Investment*, Warsaw, Urząd Rady Ministrów, 1969 (in Polish)).

Kalecki was decidedly against such an extension of the scope of investment efficiency calculation. He considered that, in a socialist economy, it was methodologically appropriate to calculate the *relative* efficiency of substitution between production factors required to produce *a given use-value*. Therefore he consistently opposed attempts to replace this type of calculation with a micro-economic calculation of *absolute* efficiency whose rationale is exchange value. In his opinion, it was primarily the plan which should decide the volume and structure of use-value. In 'An Outline of a Method of Constructing a Perspective Plan' Kalecki wrote:

> It should be added that the calculations of efficiency should be applied as thoroughly as possible for the purposes mentioned above. . . . On the other hand, there is no point in applying them for anything else but the choice of technological alternatives or for the examining of the structure of foreign trade. The structure of output in a planned economy cannot be determined apart from these two aspects by considerations of efficiency. . . . For, as follows from the above argument, with a given rate of growth of the national income, a given relation between unproductive investment and consumption, and a given structure of consumption, the industrial structure of output would be fully determined by the technical coefficients of production. (*Collected Works*, vol. iii, p. 274.)

As in Czechoslovakia, new regulations on the appraisal of investment efficiency in Poland did not use the concept of a marginal recoupment period. Its replacement by a discount rate of 12% cannot be considered merely as an extension of the recoupment period from six to eight years. In fact, this was the first step towards a change in the methodological foundations of investment efficiency calculation and a consequence of its extended scope. Furthermore, due to this extension, new regulations divided investment into five categories depending on their importance to the economy as a whole. This signified the awareness of limitations which arise when, in a centrally planned economy, all investment projects are reduced to a single common denominator based only on market criteria in an otherwise non-market environment. It also meant, however, that the calculation would resort to subjective criteria used to classify investment into the various categories, thus weakening its internal coherence.

Similar changes in the practice of investment efficiency calculation were introduced in the Soviet Union (see e.g., L. W. Kantorovich, W. N. Bogachev, and W. L. Makarow, 'Ob otsenkie effiektivnosti kapitalnikh zatrat', *Ekonomika i Matematicheskiye Metody*, 6/6, 1970). Under the methodology for evaluation of the economic efficiency of investment introduced in the Soviet Union in 1977, the uniform norm of efficiency of investment outlay was called the 'normative rate of profit' (see 'Metodika opriedieleniya ekonomicheskoy effiektivnosti ispolzovaniya v narodnom khoziaystvie novoy tiekhniki', *Ekonomicheskaya Gazieta*, 17/10, 1977).

The new principles of investment efficiency evaluation were introduced in Poland in 1975 (see 'Outline Instructions on the Method for the Economic Appraisal of Productive Investment Proposals for Technical and Organizational Progress, Scientific Co-operation, and Proposals Entailing the Use of Foreign Licenses', *Inwestycje i Budownictwo*, 24/9, 1974 (in Polish), and *The Economic Appraisal of the Efficiency of Investment and Other Development Proposals: Handbook of Instructions*, Warsaw, PWE, 1974, in Polish). They were based on discounting the flows of future costs and revenues. They linked investment efficiency with the financial system of the enterprise through the repayment of investment credits and through the interest paid on credit outstanding. The purpose of the new rules was to standardize and improve methods of calculating investment efficiency, and to link them with efficiency appraisals of current production and the financial systems of firms. The enterprise director was supposed to be responsible for the economic performance of his enterprise, contingent upon proper economic calculation. In practice, the responsibility of the directors turned out to be illusory and the experiences of the investment process of the 1970s substantiated the criticism of the methodological foundations of the new guide-lines, which was voiced much earlier (see M. Rakowski, 'On Some Fundamental Problems of the Development of Investment Efficiency Calculation', *Gospodarka Planowa*, 27/4, 1972 (in Polish); for a defence of the new guide-lines, see J. Czarnek and P. Glikman, 'On the New Method for the Economic Appraisal of Investment Efficiency', *Inwestycje i Budownictwo*, 1972, no. 1 (in Polish)).

The method of determining the investment efficiency norm, or the standard rate of interest, aroused most serious reservations. According to Kalecki's approach, the marginal recoupment period used in the Polish investment regulations in the 1960s was a macro-economic category. It was set in the course of balancing the demand for labour and its supply in a given period, while minimizing investment outlay in the economy as a whole. In the 'Outline Instructions' of 1975 the target rate of efficiency of investment was not based on any such considerations, but was made equal to the rate of interest then applied by the central bank to credits that it granted. However, it was not clear why it was exactly this target rate of investment efficiency, and what instruments were to be used in conjunction with it in order to balance the supply and demand of resources which had previously been balanced by setting an appropriate marginal recoupment period. Moreover, at the heart of these doubts there lay a more fundamental difference between the two approaches to investment efficiency calculation.

Kalecki sought to give economic calculation under socialism a social dimension. In his view, the rationale for socialism was that different criteria of social rationality should be used in economic decision-making from those used under the capitalist system. In particular, sectional and/or individual interests should be subjected to the overall social interest, defined by the central planner. On this basis, Kalecki gave prominence to the use-value in economic calculation under socialism. The aim, according to him, was to maximize the volume of national income of a given structure (determined by the central planner) rather than its exchange value.

The instructions introduced in the 1970s led to quasi-market solutions and sought to eliminate overall social considerations, like those implied by the marginal recoupment period, from efficiency calculation. In place of maximizing the volume of national income of a given structure, they proposed to maximize its exchange value. The changes aimed at adapting a market mechanism in such a way that this mechanism, and not the central planner, ultimately decided questions about the structure of production. These attempts were partly inspired by a belief that as long as investment efficiency calculation merely determines relative—and not absolute—efficiency, it is impossible to break away from the command economy.

Market prices, which in the new system were to function as objective criteria for efficiency assessments, are in fact relatively objective indicators of social production costs only under competitive market conditions. Yet, the prices used in investment efficiency appraisals in Poland during the 1970s, like the other parameters of these calculations, were manipulated and distorted to suit the preferences of the central authorities and monopolistic industrial structures. As a result, 'absolute' efficiency indicators were based on elastic but arbitrary prices (and rarely on world prices) and other manipulated parameters. The effect was to make investment efficiency calculation more voluntary than even before.

Apart from these methodological problems, the application of investment efficiency calculation also ran into serious practical difficulties. This was true both of the 1960s, when investment projects were assessed according to Kalecki's approach, and of the 1970s, since the changes introduced in this respect were less than modest. An effective choice of investment variants requires the availability of at least two independently elaborated projects for each investment. In the absence of competition, this in turn calls for appropriate organizational and institutional arrangements to secure the drawing up of alternative projects, and to allow the selection of the best variant from the overall social, and not necessarily narrow, branch of industry point of view. Kalecki laid great stress on this institutional requirement:

> I think it is essential to create a central agency which, employing well-trained engineers and economists, would not only evaluate the submitted investment projects, but also at least outline its own counter-proposals. This seems to be the only way of introducing common use of variant investment planning. The existence of such an institution could contribute to increasing the level of elementary consistency of the submitted projects (independently of the examining of their efficiency). It is only by elaborating one's own

project, even in the outline only, that one can get a grasp of fundamental data which in the presently submitted projects is, politely speaking, not always precise. (*Collected Works*, vol. iii, p. 249.)

In practice, however, sectional interests prevailed, manifesting themselves in pressures to apply the most modern and highly automated techniques of production, regardless of the financial and social costs and the actual possibilities of adapting these techniques to conditions of production in the co-operating plants and industries. Investors were primarily interested in securing for themselves the greatest possible resources, since bonuses, rewards, and other material incentives for management and work-force depended on the size of their investment commitments.

The proposal to create institutional foundations for the elaboration of alternative and competing investment projects threatened those particular industrial interests and was strongly opposed by them. There was also opposition from the central economic authorities, since Kalecki's proposal would also subject their decisions to more rigorous accounting. In consequence, the subsequent institutional reorganization went counter to Kalecki's advice. Decisions concerning new investments were not handed over to enterprises but were left with the central planner. Instead of creating a central institution which could elaborate alternative projects for major investments, it was decided in 1969 to close the Planning Commission's Bureau of Experts for Evaluation of Investment Projects, because one or another of its decisions were found to be questionable. Thus, in the 1970s, at the time of the greatest post-war investment boom in Poland, there was no institution which could independently examine the social profitability of various investment projects. The two agencies for investment efficiency appraisal which were established in 1978 found themselves largely redundant due to a very serious reduction in the number of new investment projects in that year, on the verge of the coming economic crisis. Various reservations notwithstanding, applying Kalecki's method of investment appraisal would have helped to avoid many mistaken investment decisions that were made during those years, if only industrial interests and the arbitrariness of the central authorities could have been overcome. (For a discussion of the relationships between the substance and the institutional foundations of investment efficiency calculations, as proposed by Kalecki, see J. Osiatyński, *Michał Kalecki on a Socialist Economy*, pp. 155–6.)

PART 3
Some Economic and Social Problems of People's Poland

Observations on Labour Productivity

[1]
This article was first published as 'Uwagi na temat wydajności pracy', *Życie Gospodarcze*, 15/31, 1960. With some minor editorial changes it was reprinted in M. Kalecki, *On Economic and Social Problems of People's Poland*, Warsaw, PWN, 1964, pp. 41–8.

The Hungarian translation, 'Megjegyzések a munkatermelékonység kérdéséhez', appeared in M. Kalecki, *Vállalatvezetés—Tervezes—Gazdasági növekedés*, pp. 33–9 and in M. Kalecki, *A szocialista gazdaság működéséről: válogatott tanulmányok 1956–1970*, pp. 288–96. The German translation, 'Bemerkungen zur Frage der Arbeitsproduktivität', was published in M. Kalecki, *Theorie des Wachstums und der Planung in der sozialistischen Volkswirtschaft*, pp. 171–6. The English translation, 'Observations on Labour Productivity', appeared in M. Kalecki, *Selected Essays on Economic Planning*, Cambridge, CUP, 1986, pp. 54–9.

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A Contribution to the Discussion on the Perspectives for Development of Agriculture

[1]
This is a synthesis of Michał Kalecki's contributions to the discussion at the two sessions of the Agricultural and Forestry Sciences Section of the Polish Academy of Sciences on 29 May 1961 (see *On the Perspectives for Development of Agriculture*, Warsaw, PWRiL, 1961, pp. 74–6 (in Polish)), and on 22 Apr. 1963 (see *Further Comments on the Perspectives for Development of Agriculture*, Warsaw, PWRiL, 1964, pp. 98–9 (in Polish)), supplemented by his comment on the question of labour productivity gains in agriculture. This synthesis, entitled 'Głos w dyskusji o kierunkach perspektyw rozwoju rolnictwa', first appeared in *For a Socialist Development of the Agriculture: A Discussion*, Warsaw, KiW, 1964, pp. 504–8 (in Polish); and again, with some editorial changes, in M. Kalecki, *On Economic and Social Problems of People's Poland*, pp.

77–82. This latter edn. is used in the present volume. The publisher's permission to reproduce this article is gratefully acknowledged.

The Hungarian translation, 'Hozzászólás a mezőgazdaság fejlődési irányáról szóló vitához', appeared in M. Kalecki, *Vállalatvezetés—tervezés—gazdasági növekedés*, pp. 63–7.

The problems of development of the socialized sector of Polish agriculture had been taken up by Kalecki late in 1955, when he prepared for Hilary Minc a project of a system of subsidies for agricultural producer co-operatives. The essential idea behind this project was to provide state guarantees for a part of the income of these co-operatives. It was hoped that this would provide additional incentive to co-operative's members to work on its behalf. (See Kalecki's notes: 'A Subsidy for Producer Co-operatives' and 'Credits Assistance for Producer Co-operatives', both in Polish; Kalecki's papers and the Archives of the Council of Ministers, ref. no. 3/106, GM/MK/19/55.) In Kalecki's papers there also survived a copy of the draft resolution of the government's Presidium on special financial assistance to agricultural producer co-operatives, which took account of Kalecki's suggestions presented in the above-mentioned notes. Its substance coincides with Resolution No. 74 of the Presidium of the Council of Ministers of 4 February 1956, 'On Special Financial Assistance to Agricultural Producer Co-operatives', which granted special credits to the newly established co-operatives, as well as to those whose membership increased rapidly, to provide them with higher earnings. A special fund was also created for the government's assistance to agricultural producer co-operatives (see *Monitor Polski*, 34/17, 1956, item 243; see also *Trybuna Ludu*, 18 Jan. 1956 and 8 Feb. 1956).

Another of Kalecki's contribution to the discussion on the prospects of Polish agriculture was his comment on Wiktor Herer's paper on 'The Impact of Agricultural Development on Economic Development' presented at the Conference of Political Economy Chairs, in Sept. 1964, in Zakopane. In the debate on this paper Kalecki said:

The main thesis of the paper is that the development of agricultural production lags behind that of industrial production since there are some important barriers to increasing agricultural output. These barriers, however, are bound to appear in any economic system. In the developing countries one additionally encounters the problem of a backward agricultural structure and specific land-tenure conditions. In highly developed economies difficulties in expanding farm output would appear even if there existed a market for this output. At such levels of development at which income elasticity of demand for farm products is very low, high growth rate of farm output is no longer necessary nor indeed should it be high in relation to the rate of growth of national income. Otherwise, there appear problems of finding markets for agricultural goods, farmers' strikes, struggle for sales' outlets, production quotas (as in the United States), and so on.

The question of training farmers, which—as has been said here—makes sense only after basic institutional reforms have been carried out, is an additional argument in support of Herer's thesis that one cannot quickly expand agricultural output because farmers cannot be trained rapidly. This training must be later applied in practice. The agrotechnical knowledge is acquired gradually; this process should be accelerated but one should not expect it to give stunning results in a short period of time.

Saying that jumping from one agricultural strategy to another is wrong, is not enough; we must find what was behind this error. The cause is mentioned in the paper: the desire to reach a rate of growth which was too high in relation to the objective possibilities. This in turn incited the search for a 'wonder cure', and the constant switching from one strategy to another. In realistic planning, the rate of growth of agricultural output must not be set at too high a level; it must be founded not on miracles, but on the interaction of all growth factors. Trying to account for mistakes through errors and foolishness is not a scientific explanation of human behaviour; we must yet unveil the causes behind them. The importance of this paper consists of its focus on barriers to agricultural development; it warns us against overambitious plans and at the same time also points to the need for co-ordination of all available growth factors. It also warns us against planning a fantastic rate of growth on the basis of faith in the absolute efficacy of some single factor and, as a result, getting an actual growth rate that was considerably lower than one that could have been achieved with realistic planning of agricultural development. (*Zeszyty Naukowe Uniwersytetu Łozkiego*, series III: Economic Sciences, 10/10, 1965, pp. 83–4; see also *Collected Works*, vol. iii, pp. 382–93.)

[2]
More on this subject, see 'Observations on Labour Productivity', this volume.

On the Causes of Economic Delinquency

[1]

First published as 'Próba wyjaśnienia zjawiska przestępczości gospodarczej', in *Kultura i Społeczeństwo*, 6/3, 1962, pp. 73–7, and in *Życie Warszawy*, vol. 19, 4 and 5 Oct. 1962, nos. 236 and 237. Then reproduced with minor editorial changes in M. Kalecki's *On Economic and Social Problems of People's Poland*, pp. 83–90.

The Hungarian translation, 'Kísérlet a gazdasági bűnözés jelenségének magyarázatára,' appeared in M. Kalecki, *Vállalatvezetés—tervezés—gazdasági növekedés*, pp. 68–74.

The Polish Scientific Publishers' permission to reproduce this essay is gratefully acknowledged.

The Research Committee on Social Issues of People's Poland was created in 1960 in the Polish Academy of Sciences. Its objective was to conduct complex and interdisciplinary research in the field of various present-day social and economic phenomena in Poland. Kalecki become the Committee's chairman (see decision of the Scientific Secretary of the Polish Academy of Sciences of 12 Apr. 1960; Kalecki's files). During the Committee's first term (1960–2) its research focused on the following topics: (i) changes in the distribution of personal incomes as compared with the pre-war period, and their impact on the perception of social reality; (ii) the problem of economic delinquency; and (iii) the causes behind high fertility rates in Poland.

A working group was set up under Kalecki's direction to study various aspects of the problem of economic delinquency. The materials were supplied by representatives on the group of the Highest Chamber of Control (the body responsible in Poland for overseeing the proper conduct of public administration), the Chief Audit and Control Inspectorate of the Ministry of Finance, and the Institute for Internal Trade. At the request of the working group, the Institute for Internal Trade conducted a survey of various corrupt practices in the retail trade. This survey took over six months to compile. It was initially conducted in Warsaw and later extended to Poznań and Katowice, as well as some small towns and villages. For the purposes of the study a number of typical four-person families (teacher families were selected) were provided with a non-repayable sum of zł. 2000 to be spent within a month in various shops (the average monthly wage rate net of taxation in the 'socialized sector' of the economy was zł. 1619 in 1961 and zł. 1671 in 1962). The buyers were obliged not to protest when they noticed they were cheated; they were only asked to present at one of the controlling stations what they had bought and how much they had paid for it. At these stations experts on quality, prices, and weight examined the extent of fraud. This method ensured that the results were unbiased. They pointed to the fact that even with a most liberal interpretation of fraudulent practices in the retail trade, they represented at least 2% of the total value of sales, in some product groups (meat, fruits) reaching even 6%.

On the basis of this and other information (court accounts of criminal cases) Dr Jacek Marecki prepared a report which was discussed by the working group, and then at a session of the Research Committee on Social Issues of People's Poland. After some revisions and improvements the report was accepted by the Committee and circulated to all parties concerned, both in economic ministries and in the Ministry of Justice (see 'Economic and Organizational Problems of Economic Delinquency' (in Polish); Kalecki's files). It was hoped that the report would become the basis for further studies, and especially for a search for preventive measures. These, however, had to be undertaken by a specialized institution, since Kalecki's working group, after conducting this preliminary pioneering work, could at best only carry out a co-ordinating role (see 'Polish Academy of Sciences' Research Committee on Social Issues of People's Poland, Report on Activities in 1960–2' (in Polish); Kalecki's papers).

In the same issue of *Kultura i Społeczeństwo*, together with Kalecki's article, there appeared a paper by Jacek Marecki, 'Economic Delinquency: The Mechanism and Preventive Measures', which concisely summarized the report. This practically marked the end of the Committee's work on economic delinquency. Its continuation was also not assisted by the reactions it drew from some of the economic ministries concerned. In his letter to Kalecki, of 20 Apr. 1962, the Minister of Construction and Construction Materials Industry wrote:

> The report 'Economic and Organizational Problems of Economic Delinquency' accompanied by your note of 5 May 1962 prompts me to make some comments on the problem.
>
> The Ministry fully appreciates the significance of the study undertaken by the Polish Academy of Sciences on economic delinquency, the causes behind economic corruption, and measures of preventing these highly harmful phenomena.
>
> Correct conclusions of any such study depend, among other things, on the methods used to conduct it. In my opinion, one of the conditions for success is establishing close links with the economic ministries concerned in order to benefit from their co-operation both at the stage of gathering information and in its evaluation.
>
> I take it for granted that any research undertaken under the auspices of the Polish Academy of Sciences is based on the principle of complex and non-biased analysis and that this rule extends to all researchers entrusted to examine a given topic.
>
> In the report on 'Economic and Organizational Problems of Economic Delinquency' which you have sent me there is a chapter entitled 'The Mechanism of

Economic Delinquency in the Construction Industry'. In my opinion, this was prepared without due regard to the principle of complex and unbiased gathering of data and its evaluation. The Ministry has no evidence that the author of the report, Mr Marecki, solicited from the Ministry either the necessary documentation, or asked for co-operation in its evaluation. Mainly for this reason the picture drawn by Mr Marecki does not correspond to reality, does not point to the causes of economic delinquency, and does not take into account the extent of this phenomenon when related to all our construction activities. Moreover, his conclusions are unsubstantiated.

The acceptance of such a report by the Committee and its circulation among the top-level government economic administration and other high-ranking persons I consider to be injurious to the construction industry.

In these circumstances I deem it highly desirable to discuss with you the possibility of conducting a joint and profound study of those issues in the report which relate directly to the construction industry and which could be examined together by a team of researchers representing the Polish Academy of Sciences and the Ministry of Construction and Construction Materials' Industry. (Minister of Construction and Construction Materials' Industry, ref. no. GM/2/10/25/62; the letter is in Kalecki's files.)

Kalecki turned these comments to Marecki who replied:

In the chapter on the mechanisms of economic delinquency I showed merely the most typical cases and methods of channelling off unaccounted materials and payments. The report referred to legislation and regulations due to which the theft of materials and payment of artificially inflated earnings is possible or at least facilitated.

At the same time the Ministry's regulations which could contribute to the disclosure of theft of materials (regulations on building inspection and re-inspection to check plans and cost estimates), but which are not applied in practice, were listed in the report.

We also outlined the causes behind these delinquencies; they were confirmed by the twenty-two court cases we examined (from various courts throughout the country). Both evidence given from witness-box and complex studies carried out by the court's experts pointed to these causes.

The estimate of material losses in the report is only an approximation, but it is substantiated by the documentation from building inspections. The number of unauthorized construction sites disclosed in 1959, for which no building materials were allocated (except for brick and some semi-products) and which cannot otherwise be bought on the market, points to a number of 'leaks' from state construction sites, even if no theft nor losses of these materials were disclosed there.

The documentation of the Urbanization Committee must be known to the Ministry of Construction; if it has any defects, these relate rather to its lack of a full account of illegal transfers of construction materials.

The chapter on the construction industry, as well as other parts of this report, was prepared following consultations with several responsible officials of the Ministry, and with managerial staff of construction enterprises, but of course I cannot disclose their names. (The note is in Kalecki's files.)

On this basis, in a letter of 14 Aug. 1962 Kalecki wrote to the Minister of Construction:

In reply to your letter of 20 June 1962, I would like to make the following points:

1. The letter which accompanied the report stated that neither the Committee, nor its author regarded it as a 'complete and exhaustive explanation of the phenomenon of economic delinquency', which means that the report is considered only as a preliminary enquiry into the problem.

2. The chapter on the construction industry was based on a thorough examination of twenty-two court cases, as well as on the documentation of the Urbanization Committee on unauthorized construction, which points to the existing scope for leaks of construction materials. Moreover, the author of the report made several unofficial enquiries, consulting a number of highly competent people in the sphere of construction.

3. In our work we did not request any documentation from the economic ministries because, to the best of our knowledge, they have not conducted any in-depth studies on economic delinquency. In these circumstances it was doubtful whether they could provide us at short notice—as our pioneer study had to be conducted quickly—with information which would shed some light on the problem. I would like to add here that among the court cases examined by the author of the report, not a single one was discovered and brought to court by the ministry concerned.

4. The working group which under my direction studied the problem of economic delinquency included representatives of the Highest Chamber of Control, of the Chief Audit and Control Inspectorate of the Ministry of Finance, as well as Professor Kazimierz Secomski, the deputy chairman of the Planning Commission, who oversees the sector of investment and construction. The report of Jacek Marecki was discussed during numerous meetings of the working group and at the plenary meeting of the Committee, and all comments which were made there were taken into account in preparing the final version.

5. After receiving your letter, I asked the head of the relevant department of the Highest Chamber of Control for detailed comments on the matter. Judging from the number of his comments, he was very scrupulous in his role as reviewer. Having examined these comments at length, I must state that they did not refer to the most essential points of the report and, moreover, they appeared to me in general rather doubtful.

6. Furthermore, I would like to add that from some readers of the report well acquainted with the construction industry, I have heard that it not only is not injurious to the construction industry but, much to my regret, that it is 'naïve'.

7. As was stated in the accompanying letter, the Research Committee on Social Issues in People's Poland, of the Polish Academy of Sciences, regards this report as the starting-point for further studies which, however, cannot be pursued by the Committee itself. Conducting such studies by the various economic ministries is most praiseworthy. These studies could benefit from the co-operation of the specialist research centres established for this purpose in such institutions as the General Prosecutor's Office, Institute of Law at the Polish Academy of Sciences, and the Main School of Planning and Statistics. (A copy of the letter is in Kalecki's papers.)

The initiative to establish a research institute which would systematically deal with questions of economic delinquency, as mentioned by Kalecki in the last part of his letter to the Minister of the Construction Industry, was not taken up. In a letter of 30 June 1962, the chairman of the Highest Chamber of Control wrote on this issue to Kalecki:

In reply to your letter of 5 May 1962 I regret to inform you that after thorough consideration of all the problems presented in the report on 'Economic and Organizational Problems of Economic Delinquency' I find it would not be possible to organize within the Highest Chamber of Control such a research institute as mentioned in your letter.

The Highest Chamber of Control has neither the statutory powers, nor other means which would enable it to organize and operate such an institute. (The letter is in Kalecki's files.)

Kalecki would have found the conclusion of this letter rather unexpected since in earlier discussions with the chairman of the Highest Chamber of Control the latter expressed his readiness to establish such a research agency once the report on 'Economic and Organizational Problems of Economic Delinquency' was approved by the Research Committee on Social Issues in People's Poland; in fact, the question of who could be appointed as the director of this new research agency was also discussed.

There were a number of reasons for the change in the opinion of the chairman of the Highest Chamber of Control, and the reluctant attitude of the potentially concerned economic ministries. Sooner or later, any institution systematically investigating economic delinquency was likely to come up against the interest groups to which reference is made in Kalecki's article. There was also a climate of disapproval towards establishing such an institution, arising from the contradiction between the results of the report and Kalecki's tentative conclusions, and the official view of the Highest Chamber of Control and the General Prosecutor's Office, according to which economic delinquency was declining. The studies undertaken under Kalecki's supervision indicated that the actual trend was the reverse of this, and that the cause of it was the absence of proper economic controls.

In 1967 a special commission was set up to examine the whole system of economic control. No action resulted from this until 1971, when the Council of Ministers passed a resolution on organizing 'functional' control by individual ministers; its essence was the checking of enterprise decisions not only for formal conformity with the law, but also (and indeed, above all) for their impact on enterprise economic performance. Obviously such controls make sense only under conditions of a genuine autonomy of enterprises. (For a follow-up discussion of economic delinquency in Poland, see O. Gorniok, *Economic Delinquency*, Katowice, Uniwersytet Śląski, 1986 (in Polish)).

A Comparison of Manual and White-Collar Worker Incomes with the Pre-War Period

[1]

First published as 'Porównanie dochodów robotników i pracowników umysłowych z okresem przedwojennym', *Kultura i Społeczeństwo*, 8/1, 1964, pp. 35–40; after some minor editorial changes repr. in M. Kalecki, *On Economic and Social Problems of People's Poland*, pp. 91–101.

The Hungarian translation, 'A munkások és szellemi dolgozók jövedelmének összehasonlitása a háború előtti időszakkal', appeared in M. Kalecki, *Vállalatvezetés—tervezés—gazdasági növekedés*, pp. 75–83.

The present edn. takes into account some further revisions which Kalecki intended to incorporate in this article when he prepared the 2nd edn. of his collection *On Economic and Social Problems of People's Poland* (shortly after the 1968 attacks on Kalecki's theories the Polish Scientific Publishers decided against the new edn. of the book).

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The empirical work on the volume and structure of social income and consumption had attracted Kalecki's attention from the early 1930s. In his research at the Institute for the Study of Business Cycles and Prices with the outstanding Polish economist and statistician Ludwik Landau, Kalecki estimated Polish national income in the years 1929 and 1933. These estimates were at that time unique in the world in that they divided the consumed part of income into the shares of particular social classes and strata (see M. Kalecki and L. Landau, *An Estimate of Social Income in 1929*, and M. Kalecki and L. Landau, *Social Income in 1933 and the Basis for Periodic Studies of Changes in Income*, both in *Collected Works*, vol. vi). The results of this work remain a valuable source of materials for the examination of differences in the economic status of various population groups in Poland at two turning-points in the business cycle: in 1929, when the workers' consumption reached its maximum in terms of high wages and low unemployment in the period 1927–37, and in 1933, in the trough of the 1929–33 crisis.

These studies of the income levels of manual and white-collar workers in 1929 and 1933 were the starting-point for Kalecki's analysis of the scale of income growth and structural changes in income distribution in Poland after 1945. His first studies on changes in workers' incomes between 1937 and 1954 were conducted at the end of 1955 as part of his advisory work for Hilary Minc. His report for Minc, which contains some interesting information on a period for which data on the volume and distribution of workers' income is particularly scarce, follows below in Annex 8.

ANNEX 8

Comparison of Incomes per Head of the Working Population in 1954 and in 1937[1]

The comparison between present and the pre-war incomes is based on preliminary estimates and therefore must be regarded only as a first approximation. The results, however, may shed some light on the subject.

GROSS INCOME PER HEAD OF THE WORKING POPULATION IN 1937

In 1929 the average income per head of the working population (that is, of workers and their families) was zł. 985.[1] Since the cost of living index (1929 = 100) for 1937 was 62, this average income expressed at 1937 prices was zł. 610. Such would be the value of income per head of the working population had its real value

[1] A report written for Hilary Minc, 'Porównanie dochodów na głowę ludności pracującej w roku 1959 i 1937', ref. no. GM/MK/1/56; Kalecki's files.

[1] See M. Kalecki, L. Landau, *An Estimate of Social Income in 1929*.

remained unchanged throughout the 1929–37 period. We will demonstrate below that in fact it increased only slightly.

The total earnings of the working population in 1929 were zł. 6.6bn.[2] It appears that the total gross earnings of manual and white-collar workers in big and medium-size industry in real terms remained more or less constant.[3] In 1929 it was zł. 2.4bn. From the data on changes in real wages of employees in the state administration (excluding the army and the police), allowing for a very small change in the number of jobs there, it can be concluded that the real earnings of this group increased by some 30%. We assume that this growth is true of the whole public sector, taking into account that incomes in the army and the police rose faster, while those in rail transport and the post offices rose slower than the average. Therefore, out of total earnings equal to zł. 6.6bn., in 1929 the real wage bill paid out in big and medium-size industry, i.e. zł. 2.4bn., remained unchanged; the real value of the total earnings of employees in the public sector, equal to zł. 1.9bn.,[4] rose by some 30%, while the remaining part, or zł. 2.3bn., was probably somewhere between these rates of growth. Let us therefore assume that the real value of incomes of all the working population rose by 10% to 15%.

This preliminary estimate can be partially checked against data on the contributions to the Work Fund in 1937. According to our preliminary estimate, the nominal total earnings of the working population in 1937 would range between $6.6 \times 1.10 \times 0.62 =$ zł 4.5bn., and $6.6 \times 1.15 \times 0.62 =$ zł 4.7bn., of which $1.9 \times 1.3 \times$ zł 0.62bn. zł would correspond to the earnings of those employed in the public sector (as was mentioned earlier, the cost of living index in 1937 was 62, taking 1927 = 100). Since the contributions of those employed in the private sector were set at 2% of their wages (1% paid by the employee and 1% by the employer), while of those employed in the public sector were set at 1%, the above earnings correspond to total contributions to the Work Fund of zł. 75–8m. In reality, these contributions were zł. 71m. in the financial year

[2] Ibid.

[3] See *Small Statistical Yearbook*, years 1937, 1938, 1939, vols. 8, 9, 10, respectively, Warsaw, GUS (all in Polish).

[4] See L. Landau, *Incomes of Hired Labour in 1929*, Warsaw, Institute for the Study of Business Cycles and Prices, 1934 (in Polish).

1936/7 and zł. 79m. in the year 1937/8,[5] which would mean zł. 77bn., for 1937. Correspondingly, the growth in real incomes of the working population in 1927–37 can be estimated at 13%.

Total employment increased over that period by 10%. From 1929 to 1933 the number of the employed grew by 3% to 4%.[6] During the next four years this growth was doubtless higher (due to migrations from the rural areas), since in 1933 the crisis was at its worst. Over the eight-year period, 1931–9, the population of big cities increased by 12%,[7] but the employment situation certainly improved, while in the years 1929–37 it was deteriorating.

From a 13% growth in the real earnings and a 10% growth in employment it follows that real income per head of the working population grew by 3%. Since in 1929 this income was zł. 610 at 1937 prices, then for 1937 we get $610 \times 1.03 =$ zł. 630.

NET INCOME PER HEAD OF THE WORKING POPULATION IN 1937

In 1937 the sum of zł. 550m. was deducted for income tax, social security charges, retirement funds, and contributions to the Work Fund.[8] Since according to the above estimate, the gross income of the working population in this year was some zł. 4.6bn., it means that these deductions constituted 12% of that income.

It follows that the net income per head of the working population in 1937 could be estimated by deducting 12% from zł. 630, which gives zł. 555.

COMPARISON OF REAL NET INCOME PER HEAD OF THE WORKING POPULATION IN 1954 AND IN 1937

According to preliminary estimates of the Central Statistical Office, the cost of living index for 1954, taking 1937 as 100, is some 800. Therefore net income per head of the working population in 1937, in terms of 1954 prices, can be estimated as 555×8, or zł. 4 440.

[5] See *Small Statistical Yearbook, 1939.*

[6] See M. Kalecki, L. Landau, *Social Income in 1933 and the Basis for Periodic Studies of Changes in Income.*

[7] With the exception of Gdynia, whose population grew extremely quickly [it was turned into a big sea-port then].

[8] See *Small Statistical Yearbook, 1939.*

In 1954 average net income per worker was zł. 11 700. Assuming that the number of family members per worker was on the average 1.2,[9] we have an income per head of the working population of 11 700 : 2.2 = zł. 5 320. Compared to 1937, this means a 20% growth.

This growth was due to an increase in the rate of employment of the working population; real net income per employee in fact did not increase, and probably even fell. Indeed, the average gross income per worker employed in manufacturing industry in 1937 was zł. 1 717.[10] Subtracting 10% for various deductions, we are left with zł. 1 640. At 1954 prices, it would correspond to $1640 \times 8 = 12300$. In 1954 average earnings per worker employed in manufacturing industry amounted to zł. 13 360[11] or, after average deductions for income tax (6%), it was zł. 12 500 in net terms. This means that average earnings increased by 2%. However, compared with the pre-war period, average earnings of workers in general were lower than those in the manufacturing industry.

It must be added that very significant shifts took place in income distribution between manual workers and white-collar workers. For instance, compared with 1937, in 1954 the net real earnings per worker in manufacturing industry were 17% higher, and those in mining were 20% higher. At the same time, net real earnings of white-collar workers employed in manufacturing industry fell by 49%[12] (also see Appendix).

IMPACT OF CASH BENEFITS, SOCIAL SECURITY PAYMENTS, AND PENSIONS

We have not yet considered incomes from social security benefits, insurance, and pensions. In 1937 these transfers were equal to

[9] See F. Blinowski, *The People's Government's Struggle for the Welfare of the Working Masses*, Warsaw, Prasa, 1953 (in Polish). The data quoted there is for 1952. It could therefore decrease further in 1952–4, but not significantly. However, a rough independent estimate for 1954 ranges between 1.2 and 1.3.

[10] Estimates of the Central Statistical Office; construction industry excluded (in present statistics it is not included in manufacturing industry).

[11] Estimates of the Central Statistical Office; for better comparability with the pre-war period, fire-fighters, some jobs in services outside industry, and so on, were excluded.

[12] According to estimates of the Central Statistical Office.

zł. 530m.[13] that is some 13% of total net incomes of employees, which according to our estimates were slightly over zł. 4bn.

In 1954 similar transfers amounted to zł. 9.66bn. while the total net wage bill was zł. 66.16bn.; the corresponding share was therefore 14.6%. The inclusion of these transfers does not therefore seriously affect comparisons between 1954 and 1937, increasing the index of real incomes per head of the working population from 120 to 122. It should be noticed that the structure of transfers largely changed: the share of pensions and disability payments dropped significantly, while that of sick-care benefits increased; substantial family allowances were also newly introduced.

APPENDIX

Table 3 shows changes which took place in the distribution of workers' incomes in manufacturing industry, compared to the pre-war period. The enormous levelling of earnings of white-collar workers and manual workers is striking. The differentiation between earnings of workers employed in various industries was also reduced, although on a much lesser scale and less consistently. In the industries where wages were very low before the war, i.e. in the mineral, timber, and clothing industries, wages grew significantly (especially in the mineral and timber industries) when compared with the average growth in manufacturing industry as a whole. The opposite took place in industries where prior to the war wages were higher (metal and chemical industries). Finally, in those branches in which the level of wages was close to the average (textile, paper, and leather industries), after the war wages dropped significantly below the average in the textile and paper industries while they rose relatively in the leather industry. Compared to the average for the whole manufacturing sector, wages in the food-processing industry remained at about the same level as before the war. The sum of deviations from the average, also when weighted according to the total wage bills in the individual industries, was undoubtedly reduced (see Table 3).

In the coal-mining industry, the comparison in workers' earnings is as follows. In 1937 the annual gross earnings of workers

[13] See *Small Statistical Yearbook, 1939.*

Table 3. *Differences in Gross Earnings in Manufacturing Industry in 1937 and 1954 (average earnings per worker in manufacturing = 100)*

Type of employment	1937	1954
White-collar workers in manufacturing industry	302	126
Workers in industries:		
mineral	74	96
metal	141	113
chemical	121	95
textile	95	75
paper	102	79
leather	98	115
timber	57	82
food	81	81
clothing	73	78

Table 4. *Average Annual Wages of Blue- and White-Collar Workers in 1937 and 1954*[a]

Industry	Manual workers			White-collar workers		
	1937	1954	1937 = 100	1937	1954	1937 = 100
Mineral	1 080	12 593	1 166.0	3 456	15 674	453.5
Metal	2 064	14 005	678.5	5 112	18 418	360.3
Textile	1 492	9 703	697.1	5 388	14 764	274.0
Timber	828	10 495	1 267.5	2 460	13 542	550.5
Food-processing	1 188	10 428	977.8	3 468	13 584	391.7

[a] Data for 1937 include wages in plants of categories I-VII in manufacturing industry (see *Small Statistical Yearbook, 1939*, p. 134, Table 15). For 1954, wages of manual workers are represented by wages of workers of the industrial category, while those of white-collar workers by average wages of those employed in technical, engineering, administration, and office jobs.

employed in the collieries, including paid holidays and coal allowances, but net of family allowances, was zł. 2165.94.[14] The net earnings of these workers, after deductions for insurance, the Unemployment Fund, and income tax, were zł. 1873.54.[15] In 1954

[14] According to the statistics of the Ministry of Industry and Commerce, *Statystyka Przemysłu Węglowego w Państwie Polskim za rok 1937* (Statistics of Coal-Mining Industry in Poland, in 1973, Warsaw, Ministerstwo Przemysłu i Handlu (in Polish)), p. 145, average annual earnings were zł. 2 320.42 and the family allowances were zł. 154.48.

[15] Deductions for insurance and the Unemployment Fund were calculated on the basis of the source quoted in n. 14 above which estimates them at 11.3% of average gross earnings. Income tax was calculated at a rate of 2.2%, which applies to earnings in the 2 100–2 200 bracket, see *Dziennik Ustaw R.P.*, Warsaw, 7 Jan. 1936, p. 2.

the average annual gross wage of industrial workers in collieries was zł. 19 343 and their net wage was zł. 17 718.[16]

The average annual wages of manual and white-collar workers in the years 1937 and 1954 are shown in Table 4, while transfers from the state budget to the population are given in Table 5.

Table 5. *Transfers from the State Budget to the Population, Net of Repayments (wages and wage-related earnings excluded; in zł. million)*

Sector (1)	1954 executed (2)	1955 planned (3)	1955 expected (4)	1956 planned (5)	Ratios 4:2 (6)	Ratios 5:4 (7)
Housing	972.6	993.6	993.0	1 050.1	102.1	105.7
of which:						
housing subsidies in the Ministry of Communal Services	172.1	248.8	248.2	305.3	144.2	123.0
housing subsidies in remaining ministries	800.5	744.8[a]	744.8[a]	744.8[a]	93.0	100.0
Education	919.0	968.0	960.9	1 003.7	104.6	104.4
of which:						
nursery schools in cities	396.2	431.2	427.0	463.2	107.8	108.5
nursery schools and crèches in villages	38.1	40.7	39.0	42.0	102.4	107.7
youth centres with free meals	65.0	68.5	68.1	69.2	104.8	101.6
boarding-houses for secondary schools' students	15.2	16.8	16.8	17.6	105.2	104.8
orphanages	215.2	220.5	218.0	218.0	101.3	100.0
summer camps and holiday centres	189.3	190.3	192.0	193.7	101.4	100.9
Vocational training	260.2	263.0	259.5	268.1	99.7	103.3
of which:						
job-training centres	62.3	44.3	44.0	42.5	70.6	96.6

[16] With 8.4% deducted for income tax on earnings from zł. 18 600 to zł. 19 800, see *Dziennik Urzędowy Ministerstwa Finansów*, Warsaw, 2 Feb. 1953, p. 4.

Sector (1)	1954 executed (2)	1955 planned (3)	1955 expected (4)	1956 planned (5)	Ratios 4:2 (6)	Ratios 5:4 (7)
boarding-houses for vocational training	182.3	105.2	192.0	201.6	105.3	105.0
reformatories	15.6	23.6	23.5	24.0	150.6	102.1
Higher education	120.2	143.3	143.3	159.8	119.2	111.5
of which:						
student hostels	55.2	65.4	65.4	74.8	118.5	114.4
subsidies for canteens	55.5	68.0	68.0	75.0	122.5	110.3
student vacations	9.5	9.9	9.9	10.0	104.2	101.0
Culture and arts	318.0	356.0	315.0	361.0	99.0	114.6
of which:						
subsidies covering planned deficit in publishing and in cultural services (theatres, operas etc.)	318.0	356.0	315.0	361.0	99.0	114.6
Health and physical education	1 717.3	1 899.2	2 007.9	2 116.0	116.9	105.4
of which:						
hospitals	790.1	877.4	885.0	920.0	112.0	103.9
centres for mentally disabled	129.3	132.9	140.0	146.7	108.3	104.8
TB prevention centres	248.0	260.9	261.0	266.7	105.2	102.2
crèches	114.0	137.8	135.0	155.2	118.4	115.0
health prevention centres	3.0	3.0	2.9	3.0	96.7	103.4
subsidized medicaments	429.8	483.0	580.0	620.0	134.9	106.9
health centres for children	3.1	4.2	4.0	4.4	129.0	11.0
Social security	280.0	285.0	285.0	320.0	101.9	112.3
of which:						
sanatoriums and spas	105.0	107.0	107.0	99.0	101.9	92.5
subsidies for workers' holidays	163.0	166.0	166.0	209.0	101.8	125.9
Christmas and Easter holiday subsidies	12.0	12.0	12.0	12.0	100.0	100.0

Sector	1954	1955		1956	Ratios	
	executed	planned	expected	planned	4:2	5:4
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Other social security of which:	124.7	147.0	142.3	148.2	114.1	104.1
nursing centres	80.0	99.7	96.0	101.2	120.0	105.4
social assistance to foreigners	5.6	7.2	7.0	7.0	125.0	100.0
subsidies for employees' canteens	18.0	17.3	17.3	18.0	96.1	104.1
allowance in cash and in kind	21.1	22.8	22.0	22.0	104.3	100.0
TOTAL	4 712.0	5 055.1	5 106.9	5 426.9	108.4	106.3

[a] Due to lack of data, execution for 1955 and targets for 1956 are assumed to be equal to what was planned for 1955.

In order to calculate real average income per head of population in non-farming occupations, which were quoted in the theses of the IXth Plenum of the Central Committee of the Polish United Workers' Party, the following indices were used:

	1938	1949 (first half)	1953 (first half)
Cost of living	100.0	404.7	804.8
Number of non-working persons per person employed	1.91	1.66	1.39

Furthermore, in the archives of the Council of Ministers and in Kalecki's private papers there also survived a draft of Kalecki's calculation of the index of real incomes for workers and peasants in 1949 and 1955 (see ref. no. 3/106, GM/MK/3/56). However, the method of the calculation and its result are uncertain.

The official data on the actual changes in real wages in the period of the 1949–55 Six-Year Plan in Poland has never been published, and possibly might not have been officially estimated. According to some working estimates made at the time at the Planning Commission, in the period 1949–55 the real wage rate increased by 6%. Yet, since in 1950, due to exceptionally favourable economic results, it increased by about 10–11%, in 1955 it reached only about 95% of its 1950 level (see A. Karpiński, *40 Years of Planning in Poland*, Warsaw, PWE, 1976, p. 68 (in Polish)).

Further studies on changes in incomes of manual and white-collar workers in Poland were conducted by Kalecki within the framework of

the Research Committee on Social Issues of People's Poland. Next to the analysis of causes behind economic delinquency (see pp. 338–43, this volume), in the initial period of the Committee's work Kalecki had already moved into the problem-area of comparisons of wage rates and their industrial structure. In 1962 under his supervision Lidia Beskid conducted a statistical enquiry discussed at the Committee's session (see her essay 'The Level of Real Incomes of the Working Population in Poland in 1960 as Compared to 1937', *Przegląd Statystyczny*, 10/3, 1963 (in Polish); see also M. Kalecki, 'A Report on Research Activities in 1962', in Kalecki's papers, in Polish), and in the following year another enquiry (see L. Beskid, 'The Level of Real Wages of Workers in Manufacturing and in Construction Industries in 1960 and 1937', *Przegląd Statystyczny*, 11/1, 1964 (in Polish)). These studies provided the foundations for Kalecki's summary article 'A Comparison of Manual and White-Collar Worker Incomes with the Pre-War Period' (see Kalecki's report on his research in 1963, Kalecki's papers; see also L. Beskid, 'Real Wages per Employee in 1960 as Compared to 1937', *Przegląd Statystyczny*, 11/3, 1964 (in Polish)).

In the early phase of the Committee's existence, on Kalecki's initiative an effort was also made to re-examine the preliminary results of analyses of workers' household budgets in the years 1937–8 (see Kazimierz Romaniuk, 'The Preliminary Results of the Study of Workers' Household Budgets in 1937', *Przegląd Statystyczny*, 9/2, 1962 (in Polish)).

At the same time, attempts were made to estimate changes which had taken place since the pre-war period in the incomes of the farming population. Research on farmers' incomes before the war was conducted by Leszek Zienkowski (see his *Poland's National Income 1937–1960*); the post-war period was examined by researchers from the Institute for Agricultural Economics, who also intended to study changes in family incomes in the 1955–63 period). Unfortunately, these studies did not go beyond their initial stage.

In 1965 Lidia Beskid in consultation with Kalecki examined the differences between the results of the comparison of workers' incomes before and after the war conducted by the Research Committee on Social Issues of People's Poland and of a similar study made by the Central Statistical Office, which was based on materials not available at the time to the Committee, i.e. on empirical surveys of employment and wages in 1937. The correction which she considered concerned the estimate of earnings of white-collar workers in 1937. However, as Kalecki wrote in the preface to the intended 2nd edn. of his collection of essays, *On Economic and Social Problems of People's Poland*:

In the present edition these indices were slightly revised to take account of the newly available statistical data. These revisions, however, do not change the general pattern and therefore our conclusions did not require any significant changes. (Kalecki's files.)

The revised average wage of a white-collar worker in 1937 was zł. 258.5 instead of the previous zł. 274.0, which in turn led to a fall in the average wage of all employed persons from zł. 133.8 to zł. 130.6. Some slight corrections in the indices of changes in wages for the 1937–60 period followed. All these revised indices of average wages rates and their rates of change were introduced in the present edn. of Kalecki's paper.

Kalecki's article had two reviews (see 'The Social and Cultural Promotion of the Countryside: Incomes of Manual and White-Collar Workers Today and before the War', *Trybuna Ludu*, vol. 17, 26 Mar. 1964, and 'Real Incomes Before the War and Today: An Interesting Comparison', *Życie Gospodarcze*, 19/15, 1964 (both in Polish)).

In the years 1965–7, within the framework of the Research Committee on Social Issues of People's Poland, Kalecki extended his studies on changes in the incomes of manual and white-collar workers to cover the 1956–65 period. These studies were planned to be of a much wider scope than before. Their purpose was to evaluate growth and changing proportions in the real incomes of the working population outside agriculture, as well as a comparison of their growth and dispersion with incomes of the farming population. Only the first purpose was achieved, however (for the basic conclusions of the study, see L. Beskid, 'The Real Wages in Poland in the 1956–67 Period', *Ekonomista*, 61/6, 1968 (in Polish)).

First of all, this research showed that ratios between the average wage rates of manual and white-collar workers were very stable (over the 1956–65 period the least disparity between them was in 1959). Secondly, differences in the dynamics of real wages for high-income and low-income brackets of manual and white-collar workers were examined. This confirmed the hypothesis on the large differentiation in the dynamics of average wages and wages of marginal income brackets in Poland in 1956–65. Thirdly, the impact of the differentiation in the cost of living on the dynamics of real wages was taken into account. For the first time in Poland, not only differences in the level and dynamics of wages of manual and white-collar workers, and of the lowest and highest income brackets, but also differences in the changes of respective prices at which these wages are realized, were considered.

The Committee's planned comparative survey of incomes of the urban and rural population was carried out, however. The research on changes in the incomes of various types of farms in the years 1956–65, initiated under Kalecki's supervision, as well as research on changing incomes of

the rural population, the result of which, according to the plan of the Committee's research, were to be published in 1969, were not completed. Besides lack of data and methodological difficulties, this was also due to Kalecki's illness, and later to the events in consequence of which on 30 Mar. 1968 he resigned as the Committee's chairman. His resignation was accepted on 12 Apr. 1968. The resolution of the Presidium of the Polish Academy of Sciences, of 28 Feb. 1969, terminated the existence of the Research Committee on Social Issues in People's Poland.

In-depth research on incomes of the farming population, as well as comparative studies of incomes in agricultural and in non-agricultural occupations, were not taken up by Polish economists until the mid-1970s. (See L. Beskid, *The Study on the Dynamics and Social Differentiation of Real Incomes in Poland*, p. 13. In another study the same author observes that while in 1937 the ratio of consumption of farmers to that of manual workers was 1 : 1.5, and of farmers to that of white-collar workers was 1 : 5.2, in 1967 the respective ratios were 1 : 1.1 and 1 : 1.6; see L. Beskid, *Changes in Consumption in Poland*, Warsaw, PWE, 1972, p. 82 (in Polish).)

As Beskid recalls, within the framework of the Research Committee on Social Issues of People's Poland Kalecki intended to study also the distribution of very high personal incomes, which were not included in the standard statistical surveys. On the basis of various external manifestations of wealth, he wanted to test the conventional views about the numbers of the country's richest people. This research has also not been undertaken by Polish economists.

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