INDIAN STATISTICAL INSTITUTE

ESSAYS ON ECONOMIC PLANNING

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outside Government agencies should also participate in thinking on planning in concrete terms In India it is now generally accepted that planning is desirable We have now the task of putting across to the public what planning really implies, and this has to be done at a technical and technological level To make planning real, we must have thousands of people working at various levels who would know how to formulate, execute, and assess a plan and what concrete studies and measures are required for this purpose Wider dissemination of ideas is, therefore, essential

The present publication is the first in the printed series Studies relating to Planning for National Development We propose to bring out in this series selected papers based on both the older and current studies We hope this series will add something of value to the growing body of litterateurs on planning in India

P C Mahalanobis.

PREFACE

To the first Edition

This little volume contains three essays of mine dealing with problems on economic planning The essays were written in 1955 and 1956 during my stay with the Indian Statistical Institute

Of the three essays the first one on the fundamentals of economic planning requires some comment Written early in 1955, it gives a systematic account of the ideas and methods of economic planning which existed at the time in Poland, the Soviet Union and other socialist countries, drawing especially on the experience of Poland. In the meantime considerable changes in economic planning have taken place in the various socialist countries These changes go in the three directions One is diversification of methods of planning in the various socialist countries, according to the specific historical conditions of each country Thus the picture of economic planning in socialist countries is today much more diversified than it was at the time when I wrote the essay

The second change consists in greater decentralization of planning and particularly in decentralization of management of industry In Poland this is connected with a limitation of the number of targets of the plan to basic macro-economic objectives, leaving details to be decided by the various decentralized units

The third change concerns the method of realization of the plan Administrative decisions imposed upon the socialist enterprises are increasingly replaced by the creation of economic incentives inducing the enterprises to carry out the objectives set in the plan Thus financial aspects of profitability, price policy, etc play an increasing role as methods of assuring the implementation of the plan

The changes mentioned are a result of the growth of productive forces The old methods of highly centralized planning relying in its implementation upon administrative decision rather than economic incentives were connected with rapid industrialisation under conditions of economic underdevelopment The great intensity of the industrialization process required methods reminiscent

of those of war economy Now that the socialist countries in Eastern Europe have attained a considerable degree of industrialization, other methods are required which are more flexible and give more room to the play of economic incentives Then the task was to achieve a revolution in the economic structure of society, now a task is to satisfy the needs of the people on the basis of a much more highly developed economy

Undoubtedly the growth of the socialist economy will lead also in the future to further developments in the methods of planning and economic management

Warsaw, 11 July 1958 OSKAR LANGE

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PUBLISHER'S NOTE

THERE are today a number of under-developed countries which realize that planned economic development is the only way to overcome their backwardness and that a successful plan of economic development implies the building of a strong nationalized sector as the driving force of the development of the whole national economy The essays in this book by one of Poland's leading economists, the late Professor Oskar Lange, contain many points that will help to decide whether and to what extent the experience of economic planning in the Soviet Union and in People's Democracies is of practical value

The first essay gives a brief comparative analysis of the capitalist, socialist and national revolutionary patterns of economic development of our times and discusses the question of planned economic development in the context of international cooperation This replaces an essay that appeared in the first edition which has been omitted in this second edition

In the second essay, it is shown that an intensification of the degree of capital accumulation is the only solution for underdeveloped countries, and measures that must be taken to assure the desired capital accumulation are suggested

The third essay is on input-output analysis and deals with its scope, Marxian schemes, input-output relations in a multi-sector model, the effect of the technological conditions of production on input-output relations, consumption and investment and economic growth and effects of investment on national income and employment.

The fourth and last essay is a new one which did not appear in the first edition. It deals with the role of science in shaping the productive forces, the economic basis, and the superstructure of socialist society It concludes with the observation that novel links shaped between various sciences, novel instruments of research, novel forms of research organisation and novel ways of influencing natural processes will increasingly contribute to the complete realisation of the vision of scientific socialism.

ECONOMIC DEVELOPMENT, PLANNING AND INTERNATIONAL CO-OPERATION*

1. Patterns of Economic Development

Economic development is increasingly becoming the central theme of economic thought In the period which started with the end of the Second World War, the problem of economic development increasingly occupies the centre of economic thought Before that time economic development played a minor role in the thought of economic theorists, particularly among economists of the leading capitalist countries Their thought at that time was chiefly concerned with problems of economic equilibrium This was so because development was considered in these countries as something which is granted and which comes about spontaneously, and, therefore, need not be given special attention

In more recent times, however, two events happened which had the effect of making economists conscious of questions of development One was the development of the socialist countries which started with the Russian revolution after the First World War, the emergence of a number of socialist economies in Eastern Europe, and finally the embarkment of the largest nation in the world, of China, on a road to socialist development These were, in any case most of them, countries which formerly were to a lesser or greater degree under developed, and which after the social revolutions which took place began to develop in a very rapid way The most important of them, the Soviet Union, became in a brief period of forty years the second industrial power in the world. This was one factor which drew the attention of economists throughout the world to problems of development

The other factor was the national revolutionary movements in the countries which formerly were colonial, semi-colonial or in some other form dependent on the leading capitalist powers.

* *Lectures delivered by Professor Oskar Lange at Central Bank of Egypt*, Cairo, 1961.

The national revolutions, which in a number of countries were victorious, led to the establishment of new independent states or to the emancipation of existing dependent states from foreign, political and economic domination. These countries considered economic development and progress to be their chief problem. The international importance of the national revolutions became so great that the whole problem of under developed countries, of their economic progress, became a major, I may say, the major international problem. Thus again attention of economists was drawn to problems of economic development. We may say that today economic science is becoming increasingly, so to speak, development conscious, the theme of development becomes the central theme of economic thought.

As a result of these historical events which I have outlined here, we can discern three historic patterns of economic development. One is the capitalist pattern which was followed by the countries of Western Europe and the U.S.A. The second is the socialist pattern which was started in the Soviet Union, then extended to a number of countries in Eastern and Central Europe, then to China and some other Asiatic countries. The third is what I shall call the national revolutionary pattern which is establishing itself in countries which emancipate themselves from colonial or semi-colonial dependence. In this lecture I intend to give a brief comparative analysis of these three patterns of economic development. However, before going into that, I have to state what is the central issue of economic development.

The essential feature which appears in all these three patterns and distinguishes a developing economy from one which is more or less stagnant in traditional ways of life—the essential factor of economic development or, in other words, its essential mechanism—is the increase in productivity of labour. This is achieved in three ways. One is the accumulation of part of the product of the economy for purposes of productive investment, the second is technical progress, and the third is the improvement of organization of economic activities. All these three ways of increasing the productivity of human labour are strictly related to one another, these three factors appear in every developing economy, and are

common to all patterns of economic development. The most important of these three is undoubtedly productive investment

In the older economies which were stagnant through centuries, or even longer, there existed various obstacles that hampered economic development. These obstacles essentially consisted in the following. the resources available for productive investment were very small This was so for two reasons With a low productivity of labour the surplus of produce over what is needed to maintain the labour power of the community was small This economic surplus, as I shall call it, was small but furthermore a substantial part, in most cases even the major part of it, was used for non-productive purposes This non productive use of the economic surplus was due to the system of social relations, either feudal or in many countries even pre feudal, like, for instance, in some countries of Africa Under these conditions the amount of economic surplus available for productive investment was very small and this was responsible for the stagnant character of these economies In addition, the ways of economic activity were determined by tradition An economic mentality existed which was not conducive to innovation, to improvement in the technology of production This further contributed to the stagnant character of the societies in question

In all these patterns of economic development mentioned, development starts with overcoming these obstacles This implies overcoming the feudal or pre feudal system of social relations and the mental traditionalism attached to it This is necessary in order to be able to utilize a major part of the economic surplus for purposes of productive investment The removal of feudal or pre-feudal social relations marks always the beginning of economic development, it is common to all the patterns of economic development mentioned above The difference between the three patterns consists in the way in which these traditional obstacles are overcome and broken down, as well as in the way in which part of the economic surplus is mobilized to serve for productive investment It is here that the difference of these three patterns emerges.

The oldest of these patterns is the capitalist pattern. Up to the First World War it was considered to be the only possible

pattern, the pattern which is universal It was thought that any country which wants to enter the road to economic development must repeat this pattern Such was the unanimous opinion of the leading economists in the old capitalist countries But even economists, which were critical of the capitalist system, and which held socialist views, shared the same opinion *The founders of modern scientific socialism, Marx and Engels,* believed that all countries will have to pass through a stage of capitalist development which is a precondition to the development of a socialist society.

What was the essential feature of the capitalist pattern of economic development? The essential feature was capital accumulation and productive investment by the urban middle class In Western Europe, *in the towns, a middle class—the bourgeoisie* —developed which accumulated a certain amount of wealth Unlike the feudal classes it did not use its wealth for conspicuous consumption but turned it into productive investment That was the beginning of capitalist development

Where did the resources for such investment come from? *They came from different sources In the first place from profits* accumulated by the merchants who were the first capitalists These profits were used for industrial investment and brought further profits already out of industrial activities of the middle class. This again provided a source for new investment Thus profits from trade and production, partly also from financial operations of the *middle class, became the basis of the investment which led to capi*talist development But these were *not the only sources* In addition, there were other sources one, and a very important one in the emergence of capitalist development, was the exploitation of colonies Such exploitation frequently took the form of direct plunder, to mention only the great plunder of India Other forms *of exploitation were through trade monopolies At a later stage* capital investment in colonial or semi colonial countries provided an important source of capital accumulation and productive investment in the countries of Western Europe It contributed very much to accelerating their economic development Another source was *the ruin of small craftsmen* and peasants, whose property was taken over by capitalists and turned into capital.

Finally, a certain amount of capital accumulation was either performed or facilitated by the state It should not be forgotten that particularly in the earlier stage of capitalist development, the state played a rather important part, either directly investing in fields such as railroads, public utilities and sometimes even in industrial and commercial enterprises, or subsidizing private enterprises. Particularly in the construction of what is called the infrastructure or the social overheads of productive activity the state used to be very active as an investor or in subsidizing private investments Thus public investment played an important part in the capitalist pattern of development

Such was the way in which the countries of Western Europe and later the United States of America started upon the capitalist road to economic development Later with capitalist enterprise in industry, commerce, and finance already established, the profits derived from these enterprises provided the source of further capital accumulation and self sustained economic growth

This process of capitalist development was unequal in various countries International capital investment came into play as a factor accelerating the development of the less developed countries In the less developed countries the rate of profit was higher than in the more developed ones This provided an incentive for capital movements out of the countries with a greater plenty of capital resources to those where capital resources were relatively more scarce This helped to speed up the development of the less developed countries

Such was briefly the capitalist pattern of development which up to the First World War appeared to economists and, as I said, to economists of all shades of opinion, as a kind of universal law of economic development, a way which all countries must pass But we know from historic experience that other patterns of economic development have emerged in the socialist countries and, more recently, in countries which I classified as countries undergoing national revolutions

We may ask what happened, what made the capitalist way of development impracticable to solve the problems of under-developed countries and made these countries to embark upon other roads

of economic development The answer is that a new factor entered into the picture, which is the development of monopoly capitalism and imperialism Monopoly capitalism and imperialism made it impossible for the under-developed countries to follow the traditional pattern of capitalist development This is so for a number of reasons The most important is this with the development of large capitalist monopolies in the leading capitalist countries, *the capitalists of those countries lost interest in developmental* investment in the less developed countries because such investment threatened to cause competition to their established monopolistic positions Consequently, investment in under developed countries of capital from the highly-developed countries acquired a specific character It went chiefly into the exploitation of natural resources to be utilized as raw materials by the industries of the developed countries, and into developing food production in the under developed countries to feed the population of the developed capitalist *countries It also went into developing the economic infra structure* such as transportation, ports and other facilities needed to maintain economic relations with the under developed countries

In consequence the economies of the under developed countries became one sided, raw material and food exporting economies. The profits which were made by foreign capital in these countries were used not for re-investment in these countries but exported *back to the countries where the capital came from Or if used for* investment in the under developed countries, they are used for investment in production of raw material, of food and for construction of an infra structure These profits were not used for industrial investment on any major scale, which, as we know from experience, is the real dynamic factor of modern economic development This is the essential reason why the under-developed countries were not capable of following the classical capitalist path of economic development

Furthermore, there were additional reasons For political reasons the great capitalist powers supported the feudal elements in the under developed countries as an instrument of maintaining their economic and political influence. This provided another obstacle to the economic development of these countries. The repetition

of the classical pattern of economic development in the under-developed countries, with a few exceptions, turned out to be impossible. As a result new patterns of economic development emerged.

What is the essential feature of the new patterns? I shall first describe briefly the socialist pattern of economic development which by now has crystallized into a pretty clear-cut form of economic organization. The socialist revolutions took place in countries which had a particular historic situation They were under-developed, the classical capitalist pattern was not workable, though there was some industrialization on capitalist lines A limited industrialization, as like in Russia, produced an industrial working class and a political movement of the working class which became the chief agent of the social revolution

The socialist revolution started everywhere with two acts. One was the nationalization of the capitalist industry, trade, finance, transportation, which were in existence and the creation on that basis of a socialist sector in the economy The second act was in agrarian reform which abolished feudal social relations in agriculture, divided the land among the peasants, and at a later stage fostered co-operative development in agricultural production These two acts provided the basis for the accumulation of resources for productive investment

The nationalized industries, trade, finance, transport, provided a pool of profits which were used for additional industrial investment As new industrial establishments were constructed, this pool of profits became larger Again it was used for new investment and thus the nationalized industrial sector of the economy was growing by means of re-investment of its own profits In this way a process of self-sustained growth was started However, these countries were under-developed and industry played a not very large role in their economies and was not sufficient to provide resources for the large-scale investment needed. An additional source of investment was a contribution of the peasants. The peasants, having received land in the agrarian reform, were made to contribute part of their proceeds in some form of taxation, mostly compulsory delivery of the produce at a lower price to the state.

The revenue thus obtained was used for new investment. By reinvesting growing industrial profits and by investing the contribution of the agricultural population which benefited from the agrarian reform a large accumulation was started This made it possible to embark upon economic development, this development then gradually became self-sustained and cumulative.

This is the essential feature of the socialist pattern of economic development The third pattern, which I call the national revolutionary one, *is only in the making, it has not yet crystallized as* clearly as the capitalist and the socialist patterns have. If you take the various countries which emancipated themselves from colonial or semi colonial dependence you find rather large differences. Therefore, it may be somewhat more difficult to give a brief synthetic description of that pattern Notwithstanding, certain general features of that pattern already emerge

The general features of the national revolutionary pattern are the following First, similarly as in the socialist pattern, it is the state and public investments which are the most active, dynamic factor in economic development The reason is simple In the countries in question not enough of a capitalist middle class has developed to be capable of providing the capital resources for investment on a scale which is needed to achieve a break-through from the old stagnant into a developing economy Therefore, public investment must become the leading factor of economic development, its very driving force The second feature of the national revolutionary pattern is that it relies on nationalization in a different way than the socialist pattern *Nationalization of private capital played a very* prominent role in the socialist countries In the national revolutionary countries nationalization is usually limited to foreign capital or certain parts of it Very frequently the nationalization of foreign capital is not so much the result of an economic programme but of a *political conflict with the old capitalist countries which* make nationalization necessary as a means of political emancipation and of ascertaining the independence of the formerly colonial or semi-colonial countries Nationalization does not cover as a rule indigenous capital

The situation in those countries is dominated by the struggle for

national emancipation and the assertion of national independence. This creates a broad basis of national unity in which many capitalist groups participate and consequently take part in the national revolution. Furthermore, in many countries the amount of existing private capital, particularly in industry, is very small There is not much to be nationalized, not much which through nationalization may contribute as a source of capital accumulation Thus the national revolutionary pattern, while relying on public investment as the dynamic and guiding force of economic development, at the same time tries to mobilize whatever indigenous private capital exists and to encourage it to take part in the investment serving economic development. It tries to channel private investment into productive activity.

In most of the national revolutionary countries a certain amount of agrarian reforms takes place These reforms, among others, serve the objective of inducing the revenues coming from agriculture to be invested in industrial activity Feudal landholding and use of land revenues for conspicuous consumption are removed, former landholders are encouraged to find their way into industrial investment.

Such is roughly the pattern of economic development which begins to emerge and which I have classified as the national revolutionary one Both the socialist and the national revolutionary patterns have one feature in common Economic development is not spontaneous as in the classical capitalist pattern but is consciously achieved through planning

Economic planning was originally an invention of the socialist economy. But now it is gradually spreading throughout the whole world. Planning has been adopted as an instrument of economic development by national revolutionary countries, and the idea of planning even begins to enter the old capitalist economies Thus the new patterns of economic development, which I have very briefly and very generally outlined in this lecture, also lead to the development of a new technique of economic development, namely of economic development through planning. Planning becomes the basic feature and instrument of economic development in our time.

2. Planning Economic Development

Planning is a relatively new method of economic policy. It originated with the socialist economies and is an essential part of socialist economy Under conditions where the major part of the means of production becomes publicly owned, it is only natural that the utilization of these means and the process of production be subject to a general national economic plan However, planning as a method of promoting economic development has not remained limited to the socialist countries It has spread first to the countries which follow what I call the national revolutionary pattern of economic development In these countries it has become—in a similar way as in the socialist countries—the main instrument of promoting economic development More recently the idea of planning is even spreading to the old capitalist countries as a part of the growing preoccupation with economic development

As was mentioned above, in the capitalist countries up to the Second World War the main preoccupation was with problems of economic equilibrium development was a spontaneous process and was not a subject of particular attention But the rapid development of the socialist countries and the increasing importance of the problem of under developed countries, which more and more adopt the national revolutionary pattern of economic progress, have created a challenge for the old capitalist countries. The challenge is two fold First, not to stay behind the rapid rate of development of the socialist countries, to keep up in the international competition between the socialist and the capitalist economic systems, a competition which increasingly dominates the present world situation Second, the need to find a solution of the problem of economic under-development which has become a major issue in today's international politics Thus the idea of planning even reaches the old capitalist countries The fact that planning is connected with many international problems also puts forward the question of international co-operation in planning for economic development.

I will, for the present, concentrate on the question of planning economic development In the socialist countries and in the

countries following a national revolutionary pattern we plan economic development, because economic development would not, under historic conditions existent, take place by itself automatically. Consequently it must be planned

What is the essential of planning economic development? I would say that the essential consists in assuring an amount of productive investment which is sufficient to provide for a rise of national income substantially in excess of the rise in population, so that per capita national income increases The strategic factor is investment, or more precisely productive investment Consequently the problem of development planning is one of assuring that there be sufficient productive investment, and then of directing that productive investment into such channels as will provide for the most rapid growth of the productive power of national economy.

These are the essential tasks of development planning The problems which planning faces can be divided into two categories One is the mobilization of resources for purposes of productive investment; the other is the direction of the investment into proper channels These are the essential problems implied in planning

The first problem is that of mobilizing resources for investment Taking the experience of the socialist countries and of the countries following a national revolutionary pattern, a certain picture of methods employed for the mobilization of resources can be drawn These methods consist in the following one is—and this is the method which was paramountly applied in the socialist countries —nationalization of industries, finance, trade and the use of the profits thus derived for purposes of investment The other method, which particularly plays a role in the countries following the national revolutionary pattern, is nationalization of foreign-owned natural resources and the use of the profits from these resources for investment purposes.

A further method is the contribution of the peasants in countries where agrarian reforms are carried out The peasants are required, in return, to make some contribution to the state finances, which are used for purposes of investment. This frequently does not suffice and an appeal is made to resources derived from general

taxation, public loans and, in certain cases, also to deficit financing.

These methods of raising resources for investment are applied both in socialist and national revolutionary countries in various proportions. There is, also, a method which plays a particularly important role in the national revolutionary countries, and which in certain socialist countries during a transition period played a role too. This is the inducement of private savers to undertake productive investment. This implies inducing private industrialists, traders, landowners, and financial groups, to invest a considerable part of their income in the direction which is conducive to assuring the country's rapid economic development, that means essentially investment in production. This can be achieved by various ways such as, for instance, taxation of unproductive uses of wealth, compulsory saving, restrictions of distributions of profits and of such uses of profits as do not consist of productive investment, compulsory loans and all kinds of other measures. Finally, import of foreign capital may be also a source of financing productive investments. I shall deal with the latter source in greater detail later on.

Thus there is a whole catalogue of means applied in various proportions in different countries which provide the resources necessary for substantial productive investment. By substantial productive investment I mean investment which is large enough to achieve a break through, or as some economists call it—to produce the "take off", the passage from stagnation to intensive development. This obviously cannot be done by small amounts of investment which are likely to peter out in a great number of minor projects. Sufficient investment is required to produce a real, a qualitative change in the structure of national economy. This is one problem of developmental planning, namely to secure these resources for productive investment.

The second problem is the direction of investment and here I shall distinguish three sub problems. The first is how to allocate investment so as to assure the most rapid growth of production; the second is how to secure balanced development of the economy, balance between the different branches of national economy, the third is how to assure efficiency of the use of resources in economic

development, how to avoid waste of resources. These are three sub problems of the general problem of directing investment so as to assure economic development

The first sub-problem is the most important one It is concerned with choosing such types of investment as will most rapidly increase the productive power of the economy This implies a concentration of investment in fields which increase the capacity of further production, that means building up the industries which produce means of production It is only through development of the industries which produce means of production that the production capacity of the economy can be raised

This can be done, however, either directly or indirectly It is done directly through investing in the construction of, say, power plants, steel plants, machine industries, raw material production and so on It is done indirectly through foreign trade instead of investing directly in the production, say, of certain machines it may be possible to get these machines from abroad by investing in the production of such commodities which can be sold abroad in order to import the machines required Thus the productive power of the economy can be increased either directly through investing in the production of means of production, or indirectly through developing export industries which make it possible to import in the future the needed means of production Which of these two methods is used depends on all kinds of circumstances, of existing facilities for developing either directly the output of means of production, or for producing commodities for export However, if investment in exportable commodities is undertaken then obviously it must be associated with importation in exchange for these exports of machinery, steel and other means of production to increase the country's productive power

However, investment in the production of means of production is not the only type of investment needed There are two complementary types of investment which are necessary One is investment in agriculture to increase food production The experience of economic planning, particularly in the socialist countries, has shown that with the growth of industrialization, with an increasing part of the population being employed in industries or

transport services and so on, a considerable surplus of agricultural products is needed to feed the non agricultural population. Consequently complementary to the investment in the development of the output of means of production must be investment in agriculture to increase agricultural output Also a certain amount of investment in industries producing consumers goods for the population is required, for the standard of living rises with the expansion of industrial employment and output These are then the chief directions of developmental investments. The first one is the strategic one, the one which brings about economic development, and the other two are of a complementary nature necessary in order that economic development can proceed smoothly.

Finally, there is one important field of developmental investment, namely investment in the general economic infra structure of the country, such as transport facilities, roads and also social services These, too, are complementary investments needed to assure smooth economic development However, they by themselves are not a factor bringing about development One of the problems in many, if not most, under developed countries was—and this was a part of the colonial or imperialist system—that there took place a large construction of this economic infra structure purely for the needs of colonial exploitation, and not for development of the productive power of the country

In choosing various allocations of investment, or rather the right proportions between various allocations of investment, the problem of the choice of technology arises, the question whether to use labour or capital intensive methods of production. Very frequently it is being argued that since in under developed countries there exists a large supply of unemployed or underemployed labour power, the most labour intensive methods should be chosen so as to secure a rapid increase of employment

Usually the situation is such that there is a distinction between the methods of production which employ much labour and those which are more productive in the sense of contributing to the increase of net output of the economy, i e. of national income. Thus there emerges a dilemma in under-developed countries whether to use methods which are less labour intensive, provide

less employment, but increase rapidly output and national income, or whether to choose methods which are labour intensive but which lead to a slower rate of increase of output and national income. The decision to be made depends on the period for which you plan. If planning is made only for a short period, then one might argue that the most labour intensive method is the best because it leads most rapidly to the absorption of unemployment or underemployment.

However, if you take a longer view of development then you find the following : By investing in methods, as well as in industries which yield a rapid increase of output, you get a more rapid increase in national income. If a certain proportion of national income, for instance 20 per cent, is invested it turns out that by choosing the method and allocation of investment which more rapidly increases national income, even if less labour intensive, after a number of years national income will have grown to such an extent that the total amount of investment will become so great that it will provide more employment Instead, a more labour intensive method would have led to a slower growth of national income, and consequently also to a slower increase in the absolute amount of investment. Thus after a certain period it always pays—also from the point of view of employment—to use that method and that allocation of investment which contributes most to the increase in national income, i e the net product of society.

This is the basic principle to be observed in a plan which aims at a rapid increase in the productive power of the economy It may be that a certain amount of unemployed labour can be "on the side" employed in ways which use very little capital resources, and thus also be called to make some contribution to the increase in production and consequently to national income This is being done very successfully in China. But still this is, so to speak, a secondary line of activity. The strategic activity in securing rapid development must consist of such methods of production and such allocation of investments which most rapidly contribute to an increase in net output. In the long run this proves the way which provides more employment than the alternative method of starting

with labour intensive, but less productive investments simply in order to diminish underemployment.

In planning economic development usually the problem of foreign trade turns up as a major difficulty The development of industry requires in any less developed country, in the initial stage, a considerable increase in imports of machinery, steel and other means of production For in the very beginning stage of economic development these cannot be produced at home, this immediately puts a burden on the balance of payments In the second stage, when the basic industries which create the country's productive potential are already constructed and start producing, there arises a requirement for increased imports of various raw materials and also of further imports of machinery to continue the process of industrialization The process of industrialization requires increased imports

There are certain countries which are in a particularly fortunate position, which have large exportable resources providing considerable revenues in foreign exchange Before embarking on planned development, these revenues usually were not used, or only to a small extent were used for productive investment Now they can be used for that purpose. To cite examples: in Iraq export of oil provides such a resource, in Ceylon the export of rubber and tea There are such resources in the United Arab Republic such as cotton I would also classify as such an exportable resource the Suez Canal. Countries which are in such a fortunate position have immediately available a certain amount of foreign exchange, to import machines and other commodities necessary for industrial development

Countries where such exportable resources do not exist or exist in small quantities have to go through a period of austerity in imports, cutting down imports of consumers goods, particularly luxury goods, in order to free the exchange necessary to import producers goods and raw materials Very frequently, it is exactly this necessity, to impose a high degree of austerity on the consumption of imported goods, which limits the possibility of rapid economic development Here, of course, the situation can be aided by foreign capital, foreign loans, but this I will deal with a little later.

These are roughly the directions of investment required to assure economic development. These investments, however, must be co ordinated, balancing investment and production in the different branches of national economy is another important aspect of planning.

There are two kinds of balances which must be secured . one is the physical balance and the other is financial or monetary balance. The physical balance consists in a proper evaluation of the relations between investment and output In the countries which already have experience in economic planning investment coefficients are computed These coefficients indicate the amount of investment and also the composition of that investment in terms of various kinds of goods needed in order to obtain an increase in output of a product by a given amount For example, how much iron, how much coal, how much electric power is needed in order to produce an additional ton of steel On this basis the planned increase in output of various products is balanced with the amounts and types of investment It is also necessary to balance the outputs of the various sections of the economy because, as we know, the output of one branch of the economy serves as input for producing the output of another branch For instance, the output of iron ore serves as an input in the steel industry In the last mentioned field a special technique, that of input output analysis, has been developed

The physical balancing mentioned is necessary in order that the outputs of the different branches of the economy proceed smoothly This is a condition of the internal consistency of the plan If this condition is not observed bottlenecks appear The plan cannot be carried out because of physical obstacles, such as lack of raw materials, of manpower, etc.

The second kind of balancing is monetary balancing, assuring monetary equilibrium in the economy. This consists in establishing an equilibrium between the incomes of the population—wages, incomes of peasants and others—and the amount of consumers goods which will be available to the population If the amount of incomes, or more precisely that part of the incomes which is spent for purposes of consumption, should turn out greater than

the amount of available consumers goods, inflationary processes develop Thus the financial or monetary balance must establish an equilibrium between the part of incomes devoted to consumption and the output of consumers goods. Further it must establish equilibrium between the part of incomes of the population which will be used for private investment and the amount of investment goods made available to private investors. Finally, in the public sector a balance must be established between the financial funds made available for investment purposes and the amount of investment goods which will be produced or imported. In addition to those balances *it is necessary to establish the balance of foreign* payments and receipts. The financial balances are an important part of planning. Just like the lack of physical balance leads to physical obstacles to the smooth process of production, so the lack of financial balance leads to disturbances in the supply and demand for physical commodities, and finally also to physical disturbances in the process of production.

Looking back upon the experience of the countries which applied planning as a tool of economic development, I must say that it usually turned out to be difficult to maintain the proper financial balance. Few of these countries escaped inflationary processes during certain periods. These processes were due to the wage bill rising more rapidly than the output of consumers goods. However, in theory and with the experience which has been gained *in earlier years it is today quite possible to plan the financial* equilibrium of economic development in a way which avoids inflationary processes.

A last point—to be only mentioned briefly—is that of securing efficiency in the use of resources in the process of economic development. This is connected with the use of the price system. The function of the price system in economic planning is two-fold. Prices *serve as means of accounting, namely as a means of evaluating* cost of production, value of output, and comparing the two. For this purpose it is necessary to have a proper price system which reflects the social cost (and in the short run—the scarcity) *of the various means of production and the social importance of the* various products. Without such a price system, cost accounting

would not have any objective economic significance. This is one role of the price system, the other role is that of an incentive.

The plan of economic development has two aspects: in the public sector it is a directive to various public agencies and enterprises to do certain things, e.g. to invest that much in such a way, to produce in such a way at such a cost. With regard to the private sector, the plan has not the power of a directive, but is a desire expressed which must be followed by creating such incentives as will induce private producers to do exactly the things which are required from them in the plan. It is quite clear and does not require further explanation that with regard to the private sector the price system, including interest rates, is an important incentive serving to induce the private sector to do things required from it in the plan. But also in the public sector the need for incentive exists. It is not sufficient just to address administrative directives to public agencies and public enterprises. In addition to that it is necessary to create such economic incentives that the public agencies, enterprises, etc. find it in the interest of their management and their employees to do the things which are required from them in the plan. This again requires a proper price system.

Thus the price system plays in planning a role both as a basis of accounting and as an incentive inducing the people to do the things required from them in the plan. A certain general observation may be made here. It seems rather general historical experience that in the first phase of economic development, particularly of industrialization, the problem of a proper price system is not the most important one. In both the socialist and the national revolutionary types of economic development we find that in the first period the main problem is not that of the details of accounting or incentives. The main problem is assuring rapid growth of productive capacity. The question of rapidity of growth overshadows the more subtle questions of high grade efficiency. It is more important, for instance, to develop at all the machine industry than to do it in the most efficient manner. Too much preoccupation with the subtleties of economic accounting may hold up action and slow down progress. It is only on a higher

stage of economic development, when the national economy has become more complex and diversified, that the problem of efficiency and incentives becomes increasingly important It is then that the subtleties of assuring the highest efficiency of economy through proper cost accounting through properly established incentives, etc come into play

Thus—not wanting to minimize the importance of the problem—I do believe that it is not the most important problem in the first stage of economic development In this first stage, the take off stage, the real issue is to mobilize the necessary resources for productive investment, to allocate them to the branches of the economy which most rapidly increase the productive potential of the country, and to do so by the most productive technological methods At a later stage more subtle aspects of planning come into play Thus a certain crudeness of planning in the early stages of economic development is, I believe, quite justified

I have so far only very briefly mentioned the international aspects of economic planning and of economic development These are the aspects to which I will now turn

3 Economic Development and International Co-operation

The problem of international co operation acquires today new and important features This is due to the co-existence in present world economy of the three patterns of economic development of which I have spoken It is the co existence of countries with a capitalist system, countries with a socialist system, and countries which follow what I call the national revolutionary pattern of development The co existence and at the same time competition of the capitalist and socialist systems, on one side, the question of economic under development and of national revolutions with their economic consequences, on the other side, put up new problems to world economy

The problems essentially are three One is the problem of international trade under conditions where there are various economic systems and patterns of development in world economy. The second is the problem of aid and it is usually formulated in terms

of aid to the under-developed countries which underwent or are undergoing national revolutions. The third problem is political in origin, but has important economic consequences, namely the problem of disarmament

It is this last problem which I shall consider first I shall consider it first because disarmament has become the paramount political problem of our days and because its economic consequences will have important repercussions on international trade and also on the problem of action on behalf of under-developed countries I do not intend to discuss here the political aspect of the problem of disarmament With the destructive power of modern weapons the problem of disarmament has become a problem of life and death for the human race , I think it is sufficient to mention this in so far as its political aspect goes But there are economic problems involved in disarmament These problems have a different aspect in socialist and in capitalist economies.

Radical and rapid disarmament creates certain economic problems also in a socialist economy. The problems are those of re-allocation of large resources—industrial plants, equipment, raw materials and also human manpower—from production for armament to production for non-military purposes Obviously when such re-allocation is to take place rapidly on a large scale, there arise certain problems of readjustment, of new directions of production, of transfer of manpower, of organization of economic activities. In a socialist economy these problems are largely the problems of proper planning and of management of national economy. The difficulties are of a character which economists usually denote by the word frictions There are all kinds of frictional obstacles involved in the transfer of manpower and re-allocation of resources. With proper planning, however, and proper managerial skill they can be overcome

The problems are more complicated in the capitalist economy There, too, arise frictional difficulties But in addition a special type of problem arises which is peculiar to the mechanism of capitalist economy. This is the question of effective demand A large scale and rapid reduction of expenditures for armaments reduces the demand for the products of armament industries.

These reduce their output and employment, this leads to a reduction of effective demand by the population. This tends to result in a further reduction of demand for consumers goods and for investment goods. This, in turn, leads to further reductions in output and employment. The process may become cumulative causing a recession or even a depression and, consequently, mass unemployment. Therefore we find in the leading capitalist countries, particularly in the U.S.A., serious apprehension concerning the economic consequences of disarmament. Frequently we observe that whenever the political situation becomes favourable to prospects of disarmament, quotations on the Stock Exchange begin to fall.

This, however, does not imply that it is definitely impossible for the capitalist countries to carry out disarmament without running into recession or even depression. It only implies that under conditions of capitalist economy, disarmament must be accompanied by certain measures of economic policy, which are designed to counter-balance, to compensate the fall-out in effective demand, and to prevent the fall-out from generating a cumulative reduction of economic activity. This is possible by means of internal measures activating investment, public or private, and also by certain measures in the field of international economic co-operation. It is about the last-mentioned measures that I want to speak first.

One such measure is the increase in international trade, another is planned action to aid the economic progress of under-developed countries. I believe that measures of economic policy in these two fields can compensate in the capitalist economies the fall-out of effective demand caused by disarmament, moreover they can even overcompensate it, and create new conditions for economic development. At the same time, disarmament in the leading capitalist and socialist countries can free important resources, which can be utilized in an international programme of economic development of the less developed areas of the world. Various proposals were made to use part of the financial and physical resources saved by disarmament to promote economic development in those areas of the world, which most need such development. Consequently the consideration of the economic implications of

disarmament leads us to the problem of international trade and to the problem of planned aid to under-developed countries.

Let us consider the question of international trade. After the Second World War international trade suffered very much by the cold war. The cold war, for a certain period, has greatly reduced, and in certain cases almost stopped, trade between capitalist and socialist countries. It also has affected very strongly the foreign trade possibilities of the under developed countries in Asia, Africa and Latin America. For the trade connections of these countries were subjected, or at least attempts were made to subject them, to consideration of cold war policies imposed by the great capitalist powers. In the last few years the international political atmosphere improved, there was considerable relaxation of international tension and many of the under-developed countries have emancipated themselves from the influence of cold war pressure. The emancipated countries have used their newly-won freedom in economic policy to develop trade relations not only with capitalist but also with socialist countries, thus extending their area of choice of trade partners and gaining by this a better position in international trade relations.

But, we still are far from having exhausted the opportunities of expanding international trade. In Europe, for instance, the trade between the countries of Eastern and Western Europe, though it has increased in the last years, is far below the potential possibilities. The situation is even worse in Asia where still many countries are prevented from maintaining normal trade relationships with socialist countries, particularly with China. Consider the absence of any significant trade between Japan and China, which, from the point of view of economic geography, is sheer nonsense. The development of foreign trade relations unhampered by consideration of the cold war can provide for all partners concerned great opportunities of economic progress.

The most important factor in this field is the rapid development of socialist economies. It may suffice to say that the present five-year plans of the socialist countries imply that by 1965 approximately half of the world's industrial output will be produced in the socialist countries. As socialist countries comprise 35 per cent

of the world's population, this means that the *per capita* output in the socialist countries will by 1965 be higher than in the rest of the world though not higher, but still lower, than in most highly developed countries of Western Europe and the U S A.

Of the whole population of the world 19 per cent live in the developed capitalist countries 35 per cent live in the socialist countries, and 46 per cent live in countries which were until recently dependent on the leading capitalist countries and now are in various stages of their process of emancipation or of struggle for emancipation Given such a situation, it is obvious that the socialist countries will provide increasingly a market for exports as well as a source of supplies, particularly in the field of industrial products Thus if we manage to remove the restrictions on international trade which were built up during the cold war, then we may look forward towards a quite important increase in international trade

This is particularly important for the under developed countries, particularly for countries which are exporters of raw materials and in whose economic life the exports of raw materials play an important part These countries have suffered in the last few years very heavily from a fall in prices of raw materials Thus in the period from 1953 to 1958 raw material prices fell by 7 per cent while industrial prices rose by 4 per cent In the two years of the last economic recession in the leading capitalist countries 1957 and 1958, the raw material exporting countries lost in consequence of the fall of their export prices $ 2 billion each year This shows the importance of foreign trade conditions for the under developed countries It turns out that during the years 1957 and 1958 the loss suffered by these countries due to the fall of prices of the raw materials exported was equal to the amount of loans obtained from the International Bank for Reconstruction and Development over the last 6 years The loss due to the fall in export prices probably counterbalanced, and may be even surpassed, the amount of foreign loans the under-developed countries received Thus regularisation and expansion of foreign trade is essential to the economic progress of the under developed parts of the world

This, however, is not sufficient ; in addition to that the under developed countries need capital from the more advanced

countries Speaking of the need of foreign capital to the under-developed countries it must be clearly realized that economic development of these countries cannot be based on foreign aid It must be based on the mobilization of internal resources If we really want to develop all that part of the world in which 46 per cent of humanity live, then the capital resources which both the leading capitalist countries and the leading socialist countries can put at the disposal of such a development are insufficient Therefore, the internal effort of capital accumulation must be the basis of economic development However foreign capital may play an important auxiliary role, facilitating the situation particularly in the so-called take-off period, and even in the early period of self sustained development. It is just in such an early stage of development that machinery and raw materials are needed, but the industries are not yet ready to provide sufficient products for export purposes In such a transitional period foreign capital aid may be of great and even crucial importance

With regard to foreign capital we have to face one very important fact This is the decline in the role of private international capital movements This decline is of structural and permanent character It is the result of the very process of emancipation of the former colonial or otherwise dependent countries, of their embarking upon the national revolutionary road to development Under these historic conditions the requirements of the private capital ready to be invested in such countries, and the requirements of these countries as to what they expect from foreign investment are very different and not easy to reconcile

In the imperialist period, the period that started with the last quarter of the nineteenth century, private capital investment in under-developed countries did not follow the classical pattern which is described in the old text-books of economics It was investment of monopoly capital reaping exceedingly high profits not due to its economic contribution but through political domination over the country in which the investment was made Political domination provided the monopoly privileges and possibilities of excluding competition of capital from other countries. This also led to the consequence that foreign capital investment was largely of a

peculiar colonial type and did not set in motion a process of development of the economy of the dependent countries.

With the progress of the movement of emancipation from colonial and imperialist domination, these terms of investment became impossible. What was a very important inducement to investment in the less developed countries—the particular privileges foreign capital enjoyed in the undeveloped countries—disappeared. In addition, another problem emerged, namely, the problem of safety of the foreign investment, safety of private foreign capital. This problem of safety arose already in the early period of capital exports in the nineteenth century. At that time it was a question of safety of investment from the capitalist countries in the less developed countries from arbitrary expropriation and restrictions imposed by pre-capitalist governments of a feudal or even more primitive type. The desire to assure the safety of investment became a powerful force behind colonial expansion, behind establishing colonial or other forms of domination in the countries where pre capitalist conditions prevailed.

Later there came a period when international private investments flourished. These investments, however, increasingly became monopolistic in character. At present a new concern about the safety of private investments arises: the concern about their safety from nationalization. The financial circles in the leading capitalist countries when asked about investment in the underdeveloped areas of the world always put the question of guarantees—guarantees first of all against nationalization. Here the basic conflict between the requirements of private investors from the leading capitalist countries and of the countries entering upon national revolutionary development becomes apparent.

Of course, certain guarantees can be given by national revolutionary governments to various foreign capitalist groups. Such guarantees, however, must, by necessity, be limited to certain groups and limited in scope. For the national revolutionary governments cannot give guarantees which would prevent the national revolutionary states from exercising their sovereignty in determining their own pattern of economic development. The requirements of economic development of the national revolutionary countries

differ from the interests of foreign capital investors This fact is crucial in the historic period in which we live, and it puts a limitation to the possibilities of developing international private capital movements to the under-developed countries on a large scale. Such movements are not entirely impossible, but their role is limited and on the decline. They cannot play any more the historic role of an important factor in economic development Their significance becomes of secondary or even tertiary importance

One aspect of international private investments deserves particular attention The classical type of foreign investment by the leading capitalist countries was direct investment But exactly for reasons of maintaining and ascertaining their national sovereignty, the new independent countries want loans rather than direct investments. This factor limits very strongly the future of private capital investments

The international investments which increasingly dominate the scene in the present period are of two types One is investment based on bilateral agreements between state and state This type of investment is today adopted by the socialist countries in their relations with the countries following the national revolutionary pattern of development, as, for instance, in the case of the Soviet Union and the United Arab Republic in constructing the Asswan High Dam. The same type of investment rises in importance even in relations between capitalist countries and the national revolutionary countries A relation of state to state or sometimes a relation of private capitalists in the capitalist countries and the state in the national revolutionary countries occurs today with increasing frequency.

The type of investment mentioned increasingly replaces in importance the private capital investments of the classical type. Direct investments of private capitalists in the less developed countries cede their place to loans by private capitalists or by the state to the newly independent states In the field of international investments a certain important development has taken place. This development is the result of the entrance of the socialist countries, in particular, of the Soviet Union, the largest of them, in the field of aid to countries developing according to a national

revolutionary pattern The aid of the Soviet Union and of other socialist countries has already influenced, and increasingly will influence, the types of investment made by the capitalist countries in the countries following the national revolutionary pattern of development

This has become quite clear for instance, in the case of India; also the United Arab Republic may serve as an example The active role of the socialist countries, particularly of the Soviet Union, in promoting capital aid to the national revolutionary countries has caused a change in the investment policy of the leading capitalist states and of the leading private capitalist groups It has forced these states and groups to abandon to a certain extent the old type of colonial investments, and to adopt types of investment which are directly conducive to the development of the industrial potential of the new countries In the case of India, the policy of the leading capitalist groups in Great Britain was rather adverse to fostering industrial development and particularly the development of heavy industries But the moment the Indian State started to develop a steel industry with investment aid from the Soviet Union, British capitalists were quite ready to come in and provide a loan for the development of the Indian steel industry

The foreign aid policy of the socialist countries has forced capitalist countries and private capitalist monopolies to revise their investment policy in a way beneficial to the development of the national revolutionary countries This process is only in the beginning it works already in India and in the United Arab Republic, it still does not work in many other under-developed countries I am sure, however, that we are seeing the beginning of this process, and the greater the activity of other socialist countries and of the Soviet Union will be in this field, the more the leading capitalist groups and their governments will have to revise their investment policies There arises, however, the problem of co-ordination of such international investment activities, and, in particular, the problem of an international programme of development of those areas in the world economy which are still heavily under-developed Such a co-ordinated international investment programme would have to

be undertaken by, or at least under the auspices of, international organizations.

Since quite some time the countries of Asia, Africa and Latin America have been demanding the United Nations to set up an agency to finance development projects in these countries. Certain steps have been taken in this field by the United Nations, though they are of a very limited character But should disarmament really be carried out on a large scale, some part of the resources thus saved in the budgets of various countries might be used for purposes of international economic development If this happens then the question of international investment projects financed by international agencies will become of increasing importance Thus we may look forward towards a future where important international economic development is financed by funds provided through international agencies Through international agencies, that means, of course, through agencies in one or other way under the auspices of the United Nations However, though it seems to me that such a future prospect is clearly on the horizon I think that the situation at the moment is not yet ripe for it The last experience of the United Nations action in Congo has shown that the United Nations executive organs are not yet a truly international body They are used to reassert colonial or neo colonial policies In the long run the United Nations undoubtedly will play an increasing role in the planning and financing of international economic development But at the moment the United Nations executive machinery is still too much under the influence of imperialist and colonial powers to be suitable for such a task Notwithstanding the process of maturing of the United Nations Organization will proceed With the increase of the economic and political significance of the struggle for colonial emancipation and of national revolutionary countries together with the further growth of the economic potential and of the political significance of the socialist countries, the United Nations will gradually mature to perform this new task

We can look forward to the United Nations becoming a truly international agency which will not any more be capable of being used for purposes of reasserting colonial or semi colonial policies, as unfortunately was the case recently Then the United Nations

will be able to play their role as an instrument of international economic co-operation and international planning and financing economic development.

International co-operation for economic development is not limited to action in the under-developed areas of the world. Even the most developed countries in the world could benefit from such action, countries like the United States and the Soviet Union which today are the leading industrial powers of the world can, too, undertake common projects of economic development. Actually various scientists have already proposed such projects, as for instance, connecting the United States, the Soviet Union and Western Europe by railway through Alaska and the Asiatic and European continents.

I do not want to evaluate the technical or economic feasibility of such projects. I just mention them to show that even the most developed industrial countries can find a useful field of commonly planned economic co-operation. There is also the possibility of economic co-operation in the field of scientific and technical research which will rise in importance. Already we have reached a situation where certain fields of scientific and technical research, like utilization of atomic power or the conquest of space, are not accessible to smaller countries simply because they do not have sufficient economic resources for such research.

The time will come when even the largest countries will not be able to afford the expenses in certain fields of scientific and technical research and will have to pool together their resources. But already at the present stage smaller countries, which are interested in co operation in the scientific and technical field, may pool together their resources. In particular, countries which follow the national revolutionary pattern of development may wish to pool their resources together on a regional basis.

This brings me to the question of regional arrangements in co-operation for economic development. Such regional arrangements may play an important role—regional arrangements by which certain countries pool together their resources to provide for economic development. Co-operation on a broader geographical scale depends on the political situation, it requires relaxation of international

tension and peaceful co existence between countries following different patterns of development. Such co-existence opens great possibilities for concerted action in the field of economic development.

One thing, however, has to be made clear, namely what peaceful co-existence and co-operation can mean and what it cannot mean. It can mean all that I have said about pooling together resources for international development plans to the benefit of all the partners concerned It cannot mean a stoppage of processes of social progress and social change International co-operation is not possible on the terms that the struggle for emancipation from colonial rule would be stopped, and that nations which have not yet gained their independence would give up their aspirations and objectives Neither is international co operation possible on the terms that social changes do not take place in countries where they are mature, where the economic and social structure requires them and the population wants them Economic co-operation cannot imply a freezing of the *status quo* of imperialist, colonial domination or of antiquated economic and social systems

"To expect that would be unrealistic, we must face the realities of the situation Peaceful co existence and international co operation, however, can mean that such changes which become necessary and cannot be prevented take place through peaceful means and in a way which does not make them a cause of increase of international tension, and, in particular, a cause of war. This is what we realistically can aspire for a situation where by means of international co-operation necessary political and economic adjustments, national emancipation and economic and social progress are achieved in a peaceful way To be workable, it must be a situation in which progress goes on, and in which the people of the world improve their economic, social and cultural position This is the type of international co operation we all can look forward to realistically—co-operation which we can expect and which certainly is worth striving for.

1961

SOME PROBLEMS CONCERNING ECONOMIC PLANNING IN UNDER-DEVELOPED COUNTRIES

1 The Basic Problem of an Under-developed Economy

An under developed economy is an economy in which the available stock of capital goods is not sufficient to employ the total available labour force on the basis of modern technique of production In consequence, two alternatives are open to such an economy. One alternative is employment of the available labour force on the basis of a backward, primitive technique of production This implies low productivity of labour and thus low *per capita* real income The other alternative is the adoption of more advanced techniques of production and higher productivity of labour This implies, however, unemployment or underemployment of part of *the labour force, because the capital goods available do not suffice* to employ the whole labour force on the basis of modern techniques of production The failure to utilize fully the labour force leads to low *per capita* national income

Usually both situations are found in under developed economies The first prevails in fields where the capitalist mode of production has not yet entered or has entered only in the form of cottage industries organized by capitalist merchants The second exists wherever capitalist factory production has replaced handicrafts or cottage industries and led to the ruin of the small independent producers The second situation develops also in agriculture where feudal types of landownership exclude the small peasants from access to land or individual peasant production is replaced by the capitalist plantation system

The dilemma of an under developed economy may be presented as follows Let c be the value of the total stock of capital goods available and v the value of the total labour force employed Denote by α the average degree of "capital intensity" of production (the

organic composition of capital, according to Marx) We have then

$$\alpha = \frac{c}{v}. \tag{1}$$

If N is the total labour force employed (measured, for instance, in man-hours) and w is the average wage-rate, we have

$$v = Nw \tag{2}$$

The total employment is thus

$$N = \frac{c}{\alpha w} \tag{3}$$

Denote by N_0 the total available labour force The economy is under-developed whenever $N < N_0$, the ratio N/N_0 may be considered as a measure of the degree of under-development

As w cannot be reduced below a certain minimum corresponding to the biological and sociological requirements of maintenance of the working population (cost of reproduction of labour power), total employment can be raised to the full employment level only in one of the following two ways. Either α is reduced sufficiently and the economy kept at a low level of productivity, or c must increase sufficiently to make possible full employment with a value of α corresponding to modern techniques of production The latter requires capital accumulation. The relative increase in the stock of means of production necessary is proportional to $(N_0 - N)/N$ as can be easily seen from formula (3)

Obviously, only the road to capital accumulation leads the economy out of its state of under development The essential problem of under developed economies consists in capital accumulation being insufficient to make c increase to the required level within a reasonably short time In consequence of the low productivity of labour, or of unemployment or underemployment, the surplus of the national income over what is needed for the reproduction of the labour force—we shall call it simply the economic surplus—is small This, however, is not the most important obstacle to capital accumulation The fundamental obstacle is the fact that such economic surplus as is available is not utilized for capital accumulation in the under-developed economies

The causes which have prevented the utilization of that surplus for capital accumulation are basically the following:

One cause is the feudal mode of production and the corresponding way of life of the old feudal ruling classes. The feudal mode of production is characterized by low productivity and correspondingly a low economic surplus is produced. The feudal ruling class, however, use the small surplus produced for conspicuous consumption, i e for unproductive purposes. In this connection, the distinction of the classical English economists, particularly Smith and Ricardo, between productive and unproductive labour may be recalled. The landed aristocracy was accused by Smith and Ricardo of squandering the nation's resources in conspicuous consumption and unproductive employment of labour services, instead of utilizing their incomes for capital accumulation and consequent productive employment of labour

As a major part of the under developed countries became subject to colonial rule, this drain of the small economic surplus was increased by the very expensive colonial administration When an under-developed country remained independent, the same drain was usually performed by the domestic monarchy and its officials.

In the period of monopoly capitalism which started towards the end of the nineteenth century, the unproductive drain of the economic surplus of the under-developed countries is reinforced through profit-taking by foreign capital. Foreign capital comes to the under-developed countries under colonial or semi-colonial conditions i e it treats these countries as sheltered reserves for monopolistic exploitation The monopoly profits made in this way are, on the whole, not reinvested in a way conducive to the economic progress of the under-developed countries A major part of the profit of foreign capital is taken out from the under-developed countries and used for the economic development of the metropolitan countries (this manifested itself, among others, in such forms as the continuous excess of imports over exports in the leading capitalist countries of Western Europe), or are invested in such ways as not to create competition for the basic industries owned by the same monopolistic groups in the metropolitan countries. As these are—as a rule—heavy industries, such capital as is reinvested in the

under-developed countries is invested in consumers goods industries and in the production of raw materials and staple food products.

This leads to the well-known one-sided character of the economy of under-developed countries · capital-extensive techniques of production yielding low incomes on one side, large-scale unemployment and underemployment of small producers ruined by the competition of capitalist factory production and by the import of manufactured articles from the capitalist industrial countries on the other side; at the same time insufficient capital accumulation

From what has been said it follows that an intensification of the *degree of capital accumulation, which is the only solution for under-developed economies*, requires the removal of the following obstacles .

(*i*) abolition of all remnants of the feudal mode of production and feudal ways of life, which produce a low economic surplus and divert the produced surplus to non-productive uses,

(*ii*) liberation from colonial rule or domestic monarchies and their officialdom which use up for unproductive purposes a part of the economic surplus, and

(*iii*) *liberation from dependence on foreign monopoly capital* which deprives the under-developed countries of a part of the surplus through taking out profits and preventing balanced economic development.

These are essential prerequisites for a rate of capital accumulation sufficient to raise the degree of employment, the productivity of labour and consequently the national income.

2 Accumulation Through Planned Economic Development

The condition stated serves to remove the diversion of the major part of the economic surplus to consumption purposes or to utilization outside the under-developed countries. In addition to these measures removing the obstacles to rapid capital accumulation, positive measures must be taken in order to assure the desired capital accumulation.

Under the present historical circumstances—in the epoch of monopoly capitalism and imperialism—rapid capital accumulation cannot be assured or secured in under-developed countries by private capital A characteristic feature of the under developed countries is the lack of a sufficiently broad and wealthy class of domestic industrial capitalists *which would command the resources for substantial* investments in industrial development It is impossible to repeat the way taken in the beginning of the nineteenth century by the countries of Western Europe where capital accumulation was carried out with the private resources of the industrial middle class In Western Europe this process was also supplemented by resources derived from colonial exploitation Even under these favourable circumstances the process of industrial development was relatively slow, too slow to satisfy the social needs of modern times

Neither *is industrialization and economic development possible* through the influx of foreign capital Foreign capital, on the whole, is ready to come to the under developed countries only as monopoly capital under colonial or semi-colonial conditions This would only provide a new drain on the economic surplus of the under-developed countries and handicap their economic development in the way which was described above

However, under certain favourable conditions as in the case of a large and strong country like India, with strong rivalries among *different groups of foreign monopoly capital and with economic* aid from non capitalist countries, foreign capital may be utilized to a certain extent for economic development The extent to which this can be done is, however, strictly limited For the very conditions of such an advantageous utilization of foreign capital require development of the internal resources of the country in order to make it sufficiently independent and strong to accept foreign capital on its own terms

Under the circumstances stated, economic development can take place only on the basis of public investment, i e of accumulation performed by the State and other public institutions *(municipalities, co operatives, etc). Public investments thus become* the strategic lever of economic development of under-developed countries

The physical resources for public investments exist in the form of unemployed or underemployed labour power and of under-developed natural resources The problem of accumulation is essentially that of putting these resources to work in a way which will create capital goods, i.e means of production This implies the utilization of the resources available for the development of producers goods industries The development of producers goods industries is the basic instrument of economic progress of under-developed countries.

It may prove, as in the case of India, that even a rapid development of producers goods industries is not sufficient to absorb all of the unemployed and under-employed labour force The remainder must be absorbed in the following two ways A part can be absorbed by means of land reform which distributes land to landless peasants and to peasants who have not land enough to absorb all their labour power as well as by settlement on new land reclaimed by irrigation projects Another part can be absorbed by the development of labour-intensive handicraft and small industries The increased demand for the products of these industries caused by the employment created in consequence of the public investments in the heavy industries and by the rise of the peasant's incomes resulting from land reform provides the market for the increased output of crafts and small scale industries

The methods of financing the public investments necessary for rapid industrial development will vary according to circumstances Since the physical resources for such public investments are available, the financing problem is soluble in principle In the Soviet Union and in the People's Democracies of Europe and Asia the financial resources were furnished by (i) the profits (including turnover tax) of the nationalized industries, (ii) contributions of the peasants in the form of a part of their produce delivered to the State at reduced prices The nationalization of the large industries (largely foreign owned) and of the banking system provided the initial financial resources for public investment The land reform enabled the peasants to contribute a certain part of their product to the industrialization of the country These means of financing were supplemented by taxation and by State loans subscribed by the population

In other countries, which like Iran and certain Latin American countries tried to liberate themselves from exploitation by foreign monopoly capital without having undergone a People's Democratic revolution, an attempt was made to acquire the resources for financing public investments for economic development by means of nationalization of foreign-owned natural resources (such as oil, copper, etc) These attempts miscarried because of foreign political intervention

If in India no major nationalization of industries is going to be undertaken in the near future, the financial resources for public investments will have largely to be derived from taxation, state loans and a certain amount of deficit financing In order to be effective, these must tap the economic surplus available. However, when a major nationalized sector has been created by means of public investment, its profits will have to become an important source of further public investment and, consequently, of further growth of the nationalized sector

3 The Role of The Nationalized Sector

Industrialization and economic development by means of public investments imply the development of a nationalized sector in the economy This sector becomes the driving force of development of the whole national economy. It is in the nationalized sector that the major part of the new investment is taking place. It is the nationalized sector which initiates the process of creating new employment and generating new incomes It is the development of the nationalized sector which—either directly through its own purchases or indirectly through the personal incomes generated in it— creates additional demand and an expanding market for consumers goods produced by the private sector of the national economy The development of the private sector which takes place is initiated by the development of the nationalized sector resulting from the public investments made

If, as is the case in most under-developed countries (it seems to be the case *in India*), *there is considerable unutilized capacity in* the private capitalist sector, profits in the private capitalist sector

increase considerably because production expands without need of much additional investment. These profits can be partly utilized, by means of taxation or borrowing or in other ways, for investment in the nationalized sector.

Industrialization of an under-developed country by means of public investment implies that the output and the capital invested in the nationalized sector increases faster than the output and the capital invested in the private sectors Thus the weight of the nationalized sector in the national economy increases

The development of a nationalized sector and its more rapid growth than that of the private sector of the national economy is, under present historical circumstances, a necessary condition for the industrialization of under-developed countries. Where the political and social conditions for the establishment by means of public investment of a nationalized sector and of its more rapid growth are non-existent, economic progress of the under-developed country is impossible, the country must remain backward until the political and economic conditions mature

4. Socialism and State-Capitalism

The development and more rapid growth of the nationalized sector does not yet by itself determine the nature of the economic and social development of the country This depends on the purpose which a nationalized sector is made to serve

The nationalized sector may be used to serve the economic, social and cultural development of the whole nation In this case it becomes the nucleus and starting point of development in the direction of a socialist society The nationalized sector, however, may also be made subservient to the interests of existing concentrations of private economic power, i e of domestic and foreign monopoly capital and the remnants of the old feudal ruling class. *In that case it is an instrument of state-capitalism, i e. for the use* of the economic activity of the State for the promotion of capitalist interests

State-capitalism is a usual component of modern monopoly capitalism. In the U S A it takes chiefly the form of armament

economy, the State acting as large-scale purchaser of armaments produced by private corporations and sold to the State at monopoly prices In this way part of the national income is transferred from the taxpayers into profits of private monopoly capital

In many countries of Western Europe, particularly France and England, a considerable nationalized sector was created after the Second World War This sector, however, is put at the service of private monopoly capitalism and frequently serves as an instrument of additional exploitation of the people by monopoly capital Many nationalized industries are operated at a deficit or at a low profit in order to provide capitalist industries with cheap raw materials, (i e coal, electric power, transport, etc) The operating deficits and costs of investment are covered by taxes paid by the people In this situation the nationalized sector is an instrument for the transformation of part of the income earned by the people into profits of monopoly capital

The difference between a state capitalist sector of the national economy and a nationalized sector acting as the starting point of a development towards socialism thus consists in the purposes which the nationalized sector serves State capitalist public investment and state capitalist enterprise serve to cover, out of taxpayers', i e the people s money the social overhead costs of private capitalist business, to provide private capitalist enterprise with conditions of external economies and with sources of increased profits Socialist public investment and socialist nationalized enterprise serve the needs of the nation as a whole, to develop the national economy in a balanced way and to free it from the domination of private concentrations of economic power

The public investment and the growth of a nationalized sector indispensable for the progress of an under developed economy may thus inaugurate either the development of state capitalism or development in a socialist direction Which way the actual development goes depends on the relation of the political power of the various social classes, which social class, or social classes, exercise decisive political power in the State

It may be said that, compared with the inherited stage of backwardness, public investment and the creation of a nationalized

sector of state-capitalist nature are a step forward for an under-developed country The creation through public investment of a state-capitalist sector means a certain amount of industrialization and general economic development which otherwise would not be forthcoming. It also implies a diminution of the dependence of the native capitalists on foreign monopoly capital and thus a certain extent of liberation of the country from the domination of imperialism For this reason the development of state capitalism in an under-developed country is, on the whole, a progressive phenomenon

State-capitalism, however, though it may initiate the progress of an under developed country, cannot sustain such progress for a long period. As we have seen, the nationalized sector must develop faster than the private sector because public investment is, under the conditions peculiar to a modern under developed country, the driving force of the development of the whole national economy If the nationalized sector acquires a state capitalist character, it becomes reduced to a subsidiary of private capitalism Its leading economic role ceases and so does economic development of the country Furthermore, it ceases to serve the balanced development of the whole national economy Consequently, in the long run, it ceases to promote economic development at all In the long run the economic progress of an under-developed country can be sustained only by the development of the economic foundations of a socialist society

21 May, 1955

SOME OBSERVATIONS ON INPUT-OUTPUT ANALYSIS

1 The Scope of Input–Output Analysis

The analysis of inter-industry relations, usually referred to as input-output analysis, serves the purpose of establishing the quantitative relations between various branches of production which must be maintained in order to assure a smooth flow of production in the national economy It studies the conditions of mutual consistency of the outputs of the various branches of the national economy which result from the fact that the output of one branch is the source of input in other branches

The idea that certain proportions must be maintained between the outputs of various branches of the national economy is at the basis of the equilibrium analysis of classical political economy and neo-classical economics The proportions referred to are, however, conceived by classical and neo-classical economic theory basically in 'horizontal' terms, i e as proportions between final products designed to satisfy the wants of consumers Under conditions of competitive capitalism, of free mobility of capital, the tendency of the rate of profit towards a 'normal' level in each branch of the national economy leads towards an equilibrium of output of the various branches In equilibrium, output is adjusted to the demand for the various products In a planned economy, it is believed, proper planning should assure the establishment of equilibrium proportions

While this idea of 'horizontal' equilibrium proportions undoubtedly points to an important aspect of the relations between the output of the various branches of the national economy, it overlooks the need of maintaining another kind of proportions, determined not by conditions of consumers' demand, but by conditions of technological relations associated with the fact that the output of certain products serves—entirely or in part—as input in the process of producing other products We may call this the problem of 'vertical' proportions

This problem of 'vertical' proportions is the subject-matter of input-output analysis. The problem was first posed by Quesnay in his famous 'Tableau Economique'. Its insight was lost by classical and neo-classical economic theory A systematic treatment as well as the fundamental solution of the problem was given by Marx in his schemes of reproduction of capital contained in volume II of Das Kapital. Outside of Marxist political economy the problem was scarcely seen, neo classical economics confining itself to the study of equilibrium conditions of the 'horizontal' type.

However, in business cycle theory of bourgeois economists the problem of 'vertical relations' between investment goods and consumers goods was bound to reappear, for it is this type of relation which is at the bottom of the phenomenon of crises and depressions Consequently, it plays an important role in Keynesian theory The 'vertical' character of the relations involved causes 'disproportionalities' in this field which are not automatically solved by the process of competition through capital moving from less profitable to more profitable branches of the economy It also explains why smooth economic development is not automatically assured under conditions of capitalism, even independently of the handicaps resulting from the specific features of monopoly capitalism

This importance of a study of the 'vertical' relations between various branches of the economy, i e , of input-output analysis, is not limited to conditions of a capitalist economy As was already pointed out by Marx, since input output relations are based on technological conditions of production, proper proportions in this field must be maintained in any economic system A study of such relations is, therefore, necessary for purposes of socialist economic planning as well as for the understanding of the working-mechanism of capitalist economy. Under conditions of socialism input-output analysis is a necessary tool of ascertaining the internal consistency of national economic plans

In the socialist countries input-output analysis takes the form of various 'statistical balances' which serve as tools of national economic planning These balances are conceived as concretisations of the general idea underlying the reproduction schemes

of Marx In the U S A , Professor Leontief has developed a type of input output analysis which, too, can be conceived as a concretisation of Marx's idea of input output relations taking place in the process of reproduction of the national product Professor Leontief's analysis takes explicitly into account the technological relations between output and input Though applied first to the economy of the U S A , this analysis like all input output analyses is also applicable to a socialist economy Indeed, it seems to me that this analysis achieves its full justification only if applied as a tool of economic planning Its technique, though first applied to a capitalist economy, points beyond the historical limitations of capitalism and can come fully into its own only under conditions of planned economy

2 The Marxian Schemes

Marx's analysis of reproduction is based on two devices First, the value of the total national product during a period of time (e g a year) is considered as being composed of three parts—the value of the means of production used up during this period (to be denoted by c—in Marx's terminology the constant capital used up), the value of the labour power directly engaged in production (to be denoted by v—in Marx's terminology the variable capital, i e the revolving wage fund), the surplus generated (to be denoted by s) Thus

Total national product $= c+v+s$

Here, c is the replacement of the means of production used up, $v+s$ is the total value added (or national income)

Secondly, the national economy is divided into two departments · one producing means of production, the other producing consumers goods Using the subscripts 1 and 2 to indicate the two departments, respectively, we shall write

$$\text{total output of means of production} = c_1+v_1+s_1$$
$$\text{total output of consumers goods} = c_2+v_2+s_2$$
$$\text{total national product} = c+v+s$$

where $c = c_1+c_2, \quad v = v_1+v_2, \quad s = s_1+s_2$

In a stationary economy (Marx's simple reproduction)

total demand for means of production $= c_1+c_2$

total demand for consumers goods $= v_1+v_2+s_1+s_2$

The total demand for means of production is equal to the joint replacement requirement of both departments, the total demand for consumers goods is equal to the joint wage fund and surplus of both departments

Putting equal demand and output of means of production, we obtain

$$c_1+c_2 = c_1+v_1+s_1 \tag{2 1}$$

which simplifies to $$c_2 = v_1+s_1 \tag{2 2}$$

The same result is obtained from putting equal total demand and output of consumers goods

That is, $$v_1+v_2+s_1+s_2 = c_2+v_2+s_2 \tag{2.3}$$

This is so, because the total national product $c+v+s$ is being given Equation (2 3) can be deduced from equation (2 1)

Equation (2 2) indicates an input output relation between the two departments of the national economy Indeed, let us write,

$$\begin{array}{l} c_1 \;+\; \overline{v_1+s_1} \\ \overline{c_2} \;+\; v_2+s_2 \end{array} \tag{2 4}$$

Department I produces means of production Part of its output equal in value to c_1 is retained within the department for replacement of the means of production used up The remainder (in the rectangle) equal in value to v_1+s_1 is transmitted to department 2 in exchange for consumers goods Department 2 produces consumers goods. Part of its output equal in value to v_2+s_2 is retained within the department for consumption. The remainder in the rectangle equal in value to c_2 is transmitted to department I in exchange for the means of production needed for replacement of those which were used up In order that production goes on smoothly, the output of the two departments must be co-ordinated in such a way that a balanced exchange takes place between the two departments,

i e $c_2 = v_1 + s_1$. The above table (2 4) indicates the input-output relations between the two departments : equation (2 2) gives the condition of proper balance between the two departments.

In an expanding economy (Marx's expanded reproduction) not all the surplus is consumed, part of it is accumulated to increase the amount of means of production and to employ more labour power We shall express this by writing

$$s = \bar{s} + s_c + s_v$$

where $\bar{s}$ is the part of the surplus consumed, s_c the part of the surplus used to increase the amount of means of production, s_v the part of the surplus used to employ more labour power.

Dividing as before the economy into two departments, we have,

total output of means of production $= c_1 + v_1 + \bar{s}_1 + s_{1c} + s_{1v}$

total output of consumers goods $= c_2 + v_2 + \bar{s}_2 + s_{2c} + s_{2v}$

total national product $= c + v + \bar{s} + s_c + s_v$

Furthermore,

total demand for means of production $= c_1 + c_2 + \bar{s}_{1c} + s_{2c}$

total demand for consumers goods $= v_1 + v_2 + s_{1v} + s_{2v} + \bar{s}_1 + \bar{s}_2$

The total demand for means of production is equal to the joint replacement and expansion requirement of both departments. The total demand of consumers goods is equal to the joint wage fund, the joint expansion of the wage fund and the joint surplus consumed in both departments.

Equality of demand and output of means of production implies

$$c_1 + s_{1c} + c_2 + s_{2c} = c_1 + v_1 + \bar{s}_1 + s_{1c} + s_{1v} \qquad (2.5)$$

which leads to

$$c_2 + s_{2c} = v_1 + \bar{s}_1 + s_{1v} \qquad (2\,6)$$

The same result can be obtained from the condition of equality of demand and output of consumers goods.

Equation (2 6) indicates the input-output relation between the two departments in an expanding economy. It can be presented by means of the following table :

$$\begin{array}{|l|l|} \hline c_1 + s_{1c} + & v_1 + \bar{s}_1 + s_{1v} \\ \hline c_2 + s_{2c} & + v_2 + \bar{s}_2 + s_{2v} \\ \hline \end{array} \qquad (2.7)$$

(The subscripts in the summation signs on the right-hand side are denoted by j in order to avoid confusion with the subscript i on the left-hand side).

Introducing input coefficients and writing

$$S_j = \pi'_j X_j \qquad (j = 1, \ldots, n) \tag{5 10}$$

we can write

$$k_i X_i = W_i\Big(\sum_j a'_{0j} X_j + \sum_j \pi'_j X_j - \sum_j \alpha_j X_j\Big) \quad (i = 1, \ldots, n) \tag{5.11}$$

Substituting this in the allocation equations (4.14) of the preceding section which indicate the allocation balances in the rows of the transaction table, we obtain

$$[a'_{ii} - \alpha_i - W_i(a'_{0i} + \pi'_i - \alpha_i)]X_i - \sum_{j \neq i}[a'_{ij} + W_i(a'_{0j} + \pi'_j - \alpha_j)]X_j = 0.$$

(5 12)

$$(i = 1, \ldots, n)$$

In order that these equations have a non-trivial solution we must have the determinant

$$\begin{vmatrix} 1 - a'_{11} - \alpha_1 - W_1(a'_{01} + \pi_1 - \alpha_1) & \ldots & -\alpha'_{1n} - W_1(\alpha'_{0n} + \pi'_n - \alpha_n) \\ \cdot \quad \cdot & \cdots & \cdot \quad \cdot \quad \cdots \\ -a'_{n1} - W_n(a'_{01} + \pi'_1 - \alpha_1), & \ldots & 1 - a'_{nn} - \alpha_n - W_n(a'_{0n} + \pi'_n - \alpha_n) \end{vmatrix} = 0 \tag{5 13}$$

This condition establishes the relations which must be maintained between the rates of investment $\alpha_1, \ldots, \alpha_n$ when the rates of consumption are determined by the 'demand equations' (5 1).

The expressions

$$a'_{0j} + \pi'_j - \alpha_j \qquad (j = 1, \ldots, n) \tag{5 14}$$

which occur in the determinant (5.13) indicate the part of the value added per unit of output value of the sector which is devoted to consumption. By multiplying these expressions by W_i we get the fraction of it which goes into consumption of the product of the i-th sector.

For illustration let us consider a two-sector model. The determinant equation can then be written in the form

$$\frac{1-a'_{11}-\alpha_1-W_1(a_{01}+\pi'_1-\alpha_1)}{a'_{12}+W_1(a'_{02}+\pi'_2-\alpha_2)}$$

$$=\frac{a'_{21}+W_2(a'_{01}+\pi_1-\alpha_1)}{1-a'_{22}-\alpha_2-W_2(a'_{02}+\pi'_2-\alpha_2)}. \qquad (5.15)$$

This equation indicates that the fraction of the value of gross output of each sector remaining after deduction of the part retained in the sector for replacement (a'_{ii}), and for consumption $W_i(a'_{0i}+\pi'_i-\alpha_i)$ and of the part devoted to investment (α_i) is proportional to the total demand (per unit of value of its output) of the other sector for the product of the first The latter is equal to the sum of the input coefficient—a'_{ij} and the output of the other sector required for consumption, i e , $W_i(a'_{0j}+\pi'_j-\alpha_j)$

Transforming the input coefficients into technical coefficients according to formula (4 13) of the preceding section and observing that

$$\pi_j=\frac{\pi_j}{p_j}, \qquad (j=1, \ldots, n) \qquad (5\ 16)$$

we can write the determinant equation (5 13) in the abbreviated form

$$\left|\delta_{ij}-\frac{p_i}{p_j}a_{ij}-W_i\left(\frac{p_0}{p_j}a_{0j}+\frac{\pi_j}{p_j}-\alpha_j\right)\right|=0 \qquad (5\ 17)$$

where $\delta_{ij}=1-\alpha_j$ for $i=j$ and $\delta_{ij}=0$ for $i\neq j$ This equation contains the wage rate p_0, the product prices $p_1 \ldots p_n$, and the per-unit surpluses $\pi_1, \ldots \pi_n$ These quantities cannot be eliminated from the equation

Thus when the rates of consumption are determined by 'demand equations' like (5 11) linking them to the national income, the relation between the rates of investment in the various sectors of the national economy cannot be expressed in purely physical and technological terms They have to be expressed in value terms and are found *according to (5 13) to depend on the input coefficients, the* rates of surplus $\pi'_1 \ldots \pi'_n$ and the consumption parameters $W_1 \ldots, W_n$ of the various sectors

As in the light of the Marxian theory of value the input coefficients can be interpreted as indicating technological conditions of production, the relations between the rates of investment are found to depend, *in addition to the technological conditions of production*, on behavioural parameters relating consumption of the various products to national income and on the per-unit surpluses in the various sectors The latter can be considered as 'sociological parameters' In a capitalist economy they are equal to the proportion of the value of each sector's output appropriated by the owners of means of production In a socialist economy the surpluses are set by considerations of social policy, providing the resources for productive investment and for society's collective consumption

6 Investment and Economic Growth

The part of the final outputs of the various sectors invested in production is added to the means of production available in the next period This makes possible in the next period an increase in the output of the various sectors of the national economy The investment *done in one period adds to the amount of means of production* in operation in the next period In consequence, a larger output is obtained in the next period The outputs of successive periods (years, for instance) are linked up in a chain through the investments undertaken in each period Thus productive investment generates a process of growth of output

Let $Q_i(t)$ be the gross physical output of the i th sector of the economy during the time period indicated by t, e g , the year 1955, and let α_i be the rate of investment of the i-th sector as defined by (5 2) in the preceding section The quantity of the output of the sector invested is thus $\alpha_i Q_i(t)$ By this amount increases the stock of product of the i-th sector available in the economy as means of production

This increment is partly retained in the sector and partly allocated to other sectors *Denote the increment allocated to the j-th* sector by $\Delta q_{ij}(t)$, $(i, j = 1, \ldots, n)$ The index t indicates the period during which the allocation takes place.

We have
$$\alpha_i Q_i(t) = \sum_j \Delta q_{ij}(t). \qquad (6.1)$$

However, not all the increment allocated is used up by the various sectors during a single unit period of time For instance, if it consists of machines or other durable equipment it will last for several units of time (years) and only a fraction of it is used up during a unit period of time Let the durability of the part of the output of the i-th sector allocated to the j-th sector as additional means of production be T_{ij} units of time T_{ij} is taken as a parameter given by the technological conditions of production and may be called the 'turnover period' of the particular type of productive equipment The reciprocal of the turnover period, i e , $1/T_{ij}$ is the rate of used up productive equipment per unit of time, it is also called 'rate of replacement' or 'rate of amortisation'

In order to produce a unit of physical output of the product of the j th sector during a unit period of time the quantity a_{ij} of the product of the i th sector must be used up during the period of time, a_{ij} is the technical coefficient Thus to increase in the next period the output of the j th sector by an additional unit, the quantity of output of the i-th sector $a_{ij}\ T_{ij}$ must be allocated to the j-th sector Then exactly a_{ij} of output of the i th sector will be used up in the next unit period in the sector and this will produce one unit of output The quantities

$$b_{ij} = a_{ij}T_{ij} \qquad (i, j = 1, \quad , n) \tag{6 2}$$

may be called the 'investment coefficients' The investment coefficients indicate the quantity of output of one sector which must be invested in the other sector in order to increase by one unit the other sector's output in the next unit period

The investment coefficients as well as their reciprocals reflect technological conditions of production, given the technical coefficients, the investment coefficients are proportional to the turnover periods of the various types of means of production

Write $Q_j(t)$ for the physical gross output of the j-th sector in the unit period under consideration and $Q_j(t+1)$ for the physical gross output of this sector in the next unit period An increment of output of the j th sector equal to $Q_j(t+1)-Q_j(t)$ requires the investment in the sector of the following quantity of the output of i th sector

$$\Delta q_{ij} = b_{ij}[Q_j(t+1)-Q_j(t)] \qquad (i, j = 1, \quad , n). \tag{6 3}$$

In view of (6.1), we have

$$\alpha_i Q_i(t) = \sum_j b_{ij}[Q_j(t+1)-Q_j(t)] \qquad (i = 1, \ldots, n). \tag{6 4}$$

These equations express the relations between the allocation of the part of the net product of each sector devoted to investment in the various sectors of the economy and the increments of output obtained in the various sectors in the next unit period.

If the amounts of product of the various sectors invested during the unit period t, i.e., $\alpha_i Q_i(t)$ are given ($i = 1, \ldots, n$), the increments of output in the next unit period can be calculated from the equations (6 4)

Denote by $B \equiv \begin{pmatrix} b_{11}, & b_{12}, \ldots & \ldots & , b_{1n} \\ b_{21}, & b_{22}, \ldots & \ldots & , b_{2n} \\ \ldots & \ldots & \ldots & \\ b_{n1}, & b_{n2}, \ldots & \ldots & , b_{nn} \end{pmatrix}$ (6 5)

the matrix of the investment coefficients The increments of output in the various sectors are then

$$Q_j(t+1)-Q_j(t) = \frac{1}{|B|} \sum_i |B_{ij}| \alpha_i Q_i(t) \tag{6 6}$$

where $|B|$ is the determinant of the matrix B and $|B_{ij}|$ is the cofactor of the element b_{ij} It is convenient to write

$$B_{ji} = \frac{|B_{ij}|}{|B|} \tag{6 7}$$

and express (6 6) in the form

$$Q_j(t+1)-Q_j(t) = \sum_i B_{ji}\alpha_i Q_i(t) \quad (j = 1, \ldots, n) \tag{6 8}$$

The coefficients B_{ij} indicate the increment of output obtained in *the j-th sector from an additional unit of the i th sector's product* invested in the j-th sector. They may be called 'intersector output-*investment ratios*' *The matrix of the coefficients B_{ij}, is the* inverse of the matrix B

The increments of output in the various sectors depend on the investment coefficients and on the amounts of product of the various sectors invested. The investment coefficients, in turn, depend on

the technical coefficients and turnover periods By virtue of (6 2) the matrix of investment coefficients can be presented as follows :

$$B = \begin{pmatrix} a_{11}T_{11}, & a_{12}T_{12}, & \dots & a_{1n}T_{1n} \\ \cdot & \cdot & \dots & \cdot \\ \cdot & \cdot & \cdot & \dots \\ a_{n1}T_{n1} & a_{n2}T_{n2}, & \dots & a_{nn}T_{nn} \end{pmatrix} \qquad (6\,9)$$

In this way the investments done in one unit period lead to an increase of output in the next period. If the rates of investment remain constant the investments in the successive unit periods are,

$$\alpha_i Q_i(t+1), \alpha_i Q_i(t+2) \qquad (i = 1. \ ., n)$$

The investment of the first unit period t are the initial 'shock' which sets in motion the process of economic growth The investments in the successive unit periods carry the process forward from one stage to another

The course of the process of economic growth can be deduced from the equation (6 4) or, for that matter, also from the equivalent equations (6 8) These are linear difference equations with constant coefficient The characteristic equation of the system (6 4) is

$$0 = \begin{vmatrix} \alpha_1+b_{11}(1-\lambda) & b_{12}(1-\lambda). \ . & b_{1n}(1-\lambda) \\ \cdot & \cdot & \\ \cdot & \cdot & \\ b_{n1}(1-\lambda) & b_{n2}(1-\lambda) & \alpha_n+b_{nn}(1-\lambda) \end{vmatrix} \qquad (6.10)$$

The solution of the difference equations indicating the gross output in the unit period t_s can be written in the form

$$Q_j(t_s) = \Sigma\, C_k h_{jk} \lambda_k^{t_s} \qquad (j = 1 \quad n) \qquad (6\,11)$$

where the λ_k are the roots of the characteristic equation, the C_k are constants determined by the outputs $Q_j(t_s)$ in the initial unit period t_s, the h_{jk} are constants determined by the matrix of the coefficients of equation (6 4), i e , by the matrix

$$\begin{pmatrix} \alpha_1+b_{11}, & b_{12}, \dots & . \ , & b_{1n} \\ \cdot & \cdot & \cdot & \dots \\ b_{n1}, & b_{n2} \dots & . \ , & \alpha_n+b_{nn} \end{pmatrix} \qquad (6\,12)$$

Thus the constants C_k reflect the initial situation of the national economy while the constants h_{jk} depend on the technological structure of the economy as expressed by the technical coefficients and the turnover periods as well as on the rates of investment *

This analysis can be generalized by considering the rates of investment as variable in time, i e , considering functions $\alpha(t)$ instead of constants α_i $(i = 1, .. , n)$ In a similar way, changes in technical coefficients and turnover periods can be investigated Instead of the constant investment coefficients, we would have to consider functions of time $b_{ij}(t)$, where $i, j = 1, . , n$ The difference equations (6 4) become then,

$$\alpha_i(t)\, Q_i(t) = \sum_j b_{ij}(t)[Q_j(t+1) - Q_j(t)] \tag{6 13}$$

Since the coefficients in these equations are not constant, the equations require more complicated methods of treatment.

The increments in output from one unit period to the next one can, however, be easily computed They are, in analogy with (6 8),

$$Q_j(t+1) - Q_j(t) = \sum_i B_{ji}\alpha_i(t)Q_i(t), \tag{6.14}$$

the matrix of the coefficients B_{ji} being now the inverse of the matrix

$$B(t) = \begin{pmatrix} b_{11}(t), & b_{12}(t), & .. & , & n_{1n}(t) \\ & & \cdot & & \\ b_{n1}(t), & b_{n2}(t), & . & ....., & b_{nn}(t) \end{pmatrix} \tag{6.15}$$

The relations between investment and the process of growth of output are here presented entirely in physical terms They are found to depend solely on the technological structure of the economy and on the rates of investment chosen The process of economic growth, however, can also be presented in value terms

* In the above, the roots λ_k are assumed to be all distinct In the case of a multiple root the corresponding h_{jk} on the right hand side of (6 11) is not a constant but a polynomial of degree one less than the multiplicity of the root. The coefficients of this polynomial are determined by the technological structure of the economy expressed by the matrix and the rates of investment. The coefficients C_k remain determined by the initial situation

In such a case, the technological investment coefficients b_{ij} are replaced by a set of coefficients,

$$b'_{ij} = \frac{\Delta X_{ij}}{X_j(t+1) - X_j(t)} \quad (i, j = 1, \ldots, n), \tag{6 16}$$

indicating the value of the output of the i-th sector which must be invested in the j-th sector in order to obtain in the latter a unit increment of output value These coefficients may be called '*investment-outlay coefficients*' or simply, '*outlay coefficients*.'*

In view of the relations (4 7) in section 4, the outlay coefficients are related to the investment coefficients as follows

$$b'_{ij} = \frac{p_i}{p_j} \cdot b_{ij} \tag{6 17}$$

Taking into account (6 2), they can also be written in the form

$$b_{ij} = a'_{ij} T_{ij} = \frac{p_i}{p_j} \cdot a_{ij} T_{ij} \tag{6.18}$$

Using the relations (4 7) of section 4 the difference equations (6.4) expressing the relations between investments in the various sectors of the economy and the increments of output obtained can be written in the value form

$$\alpha_i X^j(t) = \sum_j b_{ij}[X_j(t+1) - X_j(t)], \tag{6 19}$$

and the solutions of these equations are obtained by means of their characteristic equation which is

$$0 = \begin{vmatrix} \alpha_1 + b_{11}(1-\lambda), & \cdot & b'_{1n}(1-\lambda) \\ \cdot & \cdot & \\ \cdot & \cdot & \\ b'_{n1}(1-\lambda), & \cdots & \alpha_n + b'_{nn}(1-\lambda) \end{vmatrix} \tag{6 20}$$

* Usually the term 'capital coefficients' is used to denote the outlay coefficients For reasons exposed by the Marxian theory the term 'capital' is not appropriate in a socialist economy because it covers up the fundamental difference between the role of capital as value of means of production used to appropriate by their owners the surplus produced in the national economy and the role of means of production as an instrument in the physical process of production We, therefore, prefer to use the term 'outlay coefficients', meaning by 'outlay' the money value of the physical investments

The process of growth of the value of the output of the various sectors of the economy is thus determined—given the values of the initial outputs $X_1(t_0), \ldots, X_{vn}(t_0)$ by the outlay coefficients b_{ij} and the rates of investment α_{ij}

The outlay coefficients behave under aggregation of two or several sectors into one sector in a similar way like the input coefficients. The outlay coefficients of the new sector resulting from aggregation are the weighted means of the outlay coefficients of the sectors aggregated.

Indeed, denote by the subscript l the sector resulting from aggregation of the j-th sector and the k-th sector The outlay coefficients of the new sector are then

$$b'_{il} = \frac{\Delta X_{il}}{X_l(t+1)-X_l(t)} .$$

Since

$$\begin{cases} \Delta X_{il} = \Delta X_{ij}+\Delta X_{ik} \\ X_l(t) = X_j(t)+X_k(t) \\ X_l(t+1) = X_j(t+1)+X_k(t+1) \end{cases} \qquad (6\ 21)$$

we obtain, taking into account the definition (6 16),

$$b'_{il} = \frac{b'_{ij}[X_j(t+1)-X_j(t)]+b'_{ik}[X_k(t+1)-X_k(t)]}{[X_j(t+1)-X_j(t)]+[X_k(t+1)-X_k(t)]} \qquad (6\ 22)$$

The merit of presentation of the process of growth of output resulting from investment in value terms consists in the possibility it gives to aggregate sectors But it must be pointed out that the outlay coefficients do not reflect only the technological structure of the economy As seen from (6 17), they depend also on the relative prices of the products The result of their averaging under aggregation also depends on the relative prices of the products of the sectors aggregated

However, on the basis of the Marxian theory of value, the outlay coefficients may, under appropriate circumstances, be interpreted as indicating the quantity of social labour employed in the sector of the economy which must be 'stored up, in order to increase the output of another by an amount representing one unit of social labour. Under such interpretation, which requires that prices reflect the

amounts of social labour necessary to produce a physical unit of product, the outlay coefficients too represent the technological structure of the economy

The way in which the growth of output set in motion by investment depends entirely on the technological structure of the economy is further elucidated by the fact that the investment coefficients are, according to (6 2), products of the technical coefficients and the turnover periods, or that the outlay coefficients, according to (6 8) are the products of the input coefficients and the turnover periods * Thus the technological conditions determining the growth of output resulting from investment consist entirely of two factors One is the technical coefficients indicating current input-output relations during a unit period The other is the turnover periods which simply indicate the durability of the various means of production and consequently the rate of use up of the means of production in a single unit period of time

This disposes definitely of any mystical notions about the 'productivity' of a mythical entity capital' conceived as a separate factor of production distinguished from the physical means of production Such metaphysical entity is proved to be non-existent.

In a capitalist economy 'capital' consists of private property rights to means of production which permit the owners of the means of production to appropriate the surplus produced in the national economy. 'Capital' is the power to appropriate surplus This power, under capitalism, is measured by the money value of the means of production and hired labour power a person (or corporation) can command In a socialist economy such property rights are absent There exist simply physical means of production and certain technological conditions expressed by the *technical coefficients and turnover* periods From these technological conditions there result certain consequences concerning the quantity of social labour which must

* The fact that the investment coefficients are not independent of the technical coefficients but are derived from them by multiplication by the turnover periods seems to have been pointed out first by David Hawkins, "Some conditions of macro economic stability," Econometrica 1948, p. 313. Usually they are wrongly taken as independent data, like for instance by Professor Leontief in 'Studies in the Structure of the American Economy," Oxford University Press, New York, 1953, p 56

be 'stored up' in order to achieve a planned increase in putput. Thus there is no need in a socialist economy for any concept of 'capital'. *Such concept would only obscure the technological* character of the conditions of the process of economic growth.

7. Effects of Investment on National Income and Employment

The equations (6 19) of the preceding section can be transformed in a shape analogous to equation (6 8), i e , in a shape which presents the increment of the value of output of a sector of the national economy as a linear combination of the investment undertaken in the various sectors For greater generality it is convenient to consider the rates of investment α_i, as variable in time, i e , $\alpha_i(t)$. We obtain then,

$$X_j(t+1)-X_j(t) = \sum_i B'_{ji}\alpha_i(t)X_i(t) \quad (j = 1, \ldots, n) \tag{7 1}$$

The coefficients B'_{ji} are the elements of a matrix $(B_{ij})^{-1}$ which is the inverse of the matrix of the outlay coefficients

$$B' \equiv \begin{pmatrix} b'_{11}, & b'_{12}, & \ldots, & b'_{1n} \\ & & & \\ b_{n1}, & b_{n2}, & \ldots, & b'_{nn} \end{pmatrix} \tag{7 2}$$

This means that,

$$B'_{ji} = \frac{|B'_{ij}|}{|B'|}, \qquad (i, j = 1, \ldots, n) \tag{7 3}$$

where $|B'|$ is the determinant of B' and $|B'_{ij}|$ is the co factor of the element b'_{ij}

The coefficients B'_{ji} may be called intersector output outlay ratios'. They indicate the increment of the output (measure in value) of the j-th sector resulting from a unit increase of investment outlay of the product of the i-th sector.

Summing the equation (7.1) over all sectors of the national economy, we obtain

$$\sum_j [X_j(t+1)-X_j(t)] = \sum_j \sum_i B'_{ji}\alpha_i(t)\, X_i(t)$$

or, writing $$\beta_i = \sum_j B'_{ji} \qquad (i = 1, \ldots, n). \tag{7.4}$$

$$\sum_j (X_j(t+1) - X_j(t)) = \sum_i \beta_i \alpha_i(t) X_i(t). \tag{7.5}$$

The left hand side of equation (7.5) is the increment, from one unit period to the next, of gross national product. The coefficients β_i on the right hand side indicate the effect of a unit increase in investment oulay of the products of the various sectors of the economy on national gross product They can be called simply 'output-outlay ratios' of the products of the various sectors

A further simplification of equation (7.5) can be achieved by expressing the investment outlays in the various sectors as a fraction of the total investment outlay in the national economy. Denote by $\alpha(t)$ the overall rate of investment in the national economy during the unit period t. The total investment outlay during the unit period is

$$\alpha(t) \sum_i X_i(t)$$

Denoting further by $\mu_i(t)$ the proportion of the total investment outlay which consists of product of the i-th sector of the economy, we have

$$\alpha_i(t)\, X_i(t) = \mu_i(t) \alpha(t) \sum_i X_i(t) \tag{7.6}$$

We shall call the $\mu_i(t)$ investment structure fractions and observe that

$$\sum_i \mu_i(t) = 1$$

Substituting the relation (7.6) into equation (7.5) and observing that

$$\sum_i X_i(t) = \sum_j X_j(t),$$

we arrive at $$\sum_j (X_j(t+1) - X_j(t)) = \alpha(t) = \sum_j X_j(t) \sum_i \beta_i \mu_i(t),$$

which can also be written as

$$\frac{\sum_j (X_j(t+1) - X_j(t))}{\sum_j X_j(t)} = \alpha(t) \sum_i \beta_i \mu_i(t) \tag{7.7}$$

The left hand side of (7.7) is the rate of increase of gross national product and will be denoted by $R(t)$ In order to simplify the right hand side we shall put

$$\beta(t) = \sum_i \beta_i \mu_i(t) \tag{7.8}$$

Since $\sum_i \mu(t) = 1$, β can be interpreted as the average output-outlay ratio of the national economy Equation (7.7) can thus be expressed in the simple form

$$R(t) = \alpha(t)\beta(t) \tag{7.9}$$

Thus the rate of increase of gross national product is the product of the overall rate of investment and of the average output-outlay ratio.

Now we can calculate the effect of a given investment programme upon gross national income after a number of unit periods of time Let $\sum_j X_j(t_0)$ be the gross national product in the initial unit period t_0, and let the investment programme be given by the overall rates of investment $\alpha(t_0)$ .., $\alpha(t_n)$ and the fractions $\mu_i(t_0)$, $\mu_i(t_n)$ of the total investment outlay of products of the various sectors of the economy, $(i = 1, . ., n)$ We obtain, then, the average output-outlay ratios, $\beta(t_0)$, .. $\beta(t_n)$ The gross national product in unit period $t_s(t_s > t_0)$ is,

$$\sum_j X_j(t_s) = \prod_{t=t_0}^{t_s} [1+\alpha(t)\beta(t)] \sum_j X_j(t_0) \tag{7 10}$$

If the overall rate of investment $\alpha(t)$ and the allocation fractions $\mu(t)$ are the same during each unit period, say α and μ, this reduces to

$$\sum_j X_j(t_s) = (1+\alpha\beta)^{t_s} \cdot \sum_j X_j(t_0) \tag{7 11}$$

National income is the value of the total final output of the national economy. The value of the final output of the i-th sector in unit period, t, is according to the allocation equation (4 12) or (4.14)

$$x_i(t) = X_i(t) - \sum_j a'_{ij} X_j(t), \tag{7 12}$$

where the a'_{ij} are input coefficients

The rate of increase in national income is equal to the rate of increase of gross national product only when the change taking place in replacement is neglected Taking account of the latter, we obtain the following result

Using the same notation national income in unit period t is

$$\sum_i x_i(t) = \sum_i X_i(t) - \sum_i \sum_j a'_{ij} X_j(t)$$

The double sum on the right hand side represents that part of gross national product which is used for replacement of the means of production used up during the unit period, i e, amortisation. Let us denote the rate of replacement (rate of amortisation) during unit period t by

$$\sigma(t) = \frac{\sum_i \sum_j a_{ij} X_j(t)}{\sum_i X_i(t)}$$

We then can write

$$\sum_i x_i(t) = \sum_i X_i(t)[1-\sigma(t)].$$

Denoting by $r(t)$ the rate of increase of national income and by $R(t)$ the rate of increase of gross national product, we obtain

$$\frac{\sum_i x_i(t+1)}{\sum_i x_i(t)} = 1+r(t) = \frac{\sum_i X_i(t+1)[1-\sigma(t+1)]}{\sum_i X_i(t)[1-\sigma(t)]}$$

whence the relation

$$1+r(t) = [1+R(t)]^{\frac{1-\sigma(t+1)}{1-\sigma(t)}} \tag{7.13}$$

between the rate of increase of national income $r(t)$ and the rate of increase of gross national product $R(t)$

In the relation obtained $1+r(t)$ is the growth coefficient of national income, $1+R(t)$ is the growth coefficient of gross national product. $1-\sigma(t)$ and $1-\sigma(t+1)$ represent the fraction of gross national product in the respective unit periods t and $t+1$ which does not serve for replacement it may be called the final output ratio Thus relation (7 13) states that the growth coefficient of national income is equal to the growth coefficient of gross national product multiplied by an expression indicating the change in the output ratio

National income in unit period t_s is related to national income in the initial unit period $t_0 (t_s > t_0)$ by formulae analogous to (7 10) and (7.11) namely

$$\sum_i x_i(t_s) = \prod_{t=t_0}^{t_s} [1+r(t)] \sum_i x_i(t) \tag{7.14}$$

and, in case when $r(t) = r =$ constant

$$\sum_i x_i(t_s) = (1+r)^{t_s-t_0} \sum_i x_i(t_0)$$

In view of (7.9) and (7.14) in this paper the expression (7 14) can also be written in the more explicit form

$$\sum_i x_i(t_s) = \prod_{t=t_0}^{t_s} \left\{ \left[1+\alpha(t)\cdot\beta(t) \right]^{\frac{1-\sigma(t+1)}{1-\sigma(t)}} \right\} \cdot \sum_i x_i(t) \qquad (7\ 15)$$

The total employment generated by the gross national product is calculated as follows Denote as in section 4 by a'_{0j} the input coefficient indicating the value of direct labour force needed to produce a unit of value of product in the j-th sector We shall call them for convenience 'employment coefficients' The total employment (in value units) corresponding to gross national product in unit period t is, according to the balance equation (4 1)

$$\sum_j a_{0j} X_j(t)$$

Consequently the increment of total employment from one unit period to the next is $\sum_j a'_{0j}[X_j(t+1)-X_j(t)]$

Taking into account equation (7 1), we find

$$\sum_j a'_{0j}[X_j(t+1)-X_j(t)] = \sum_i a'_{0j} \sum_i B_{ji} \alpha_i(t) X_i(t),$$

or, in view of (7 6),

$$\sum_j a'_{0j}[X_j(t+1)-X_j(t)] = \sum_j a'_{0j} \sum_i B'_{ji} \mu_i(t) \alpha(t) \sum_i X_i(t) \qquad (7\ 16)$$

This expression can be simplified as follows Write

$$\gamma_i = \sum_j a'_{0j} B_{ji} \qquad (i = 1, \ldots, n), \qquad (7\ 17)$$

where γ is the additional amount of employment (in value units) created in the national economy by a unit increase in investment outlay of product of the i th sector of the economy We may call it the 'employment outlay ratio' of the product of the i-th sector. Then we obtain

$$\frac{\sum_j a'_{0j}[X_j(t+1)-X_j(t)]}{\sum_j X_j(t)} = \alpha(t) \sum_i \gamma_i \mu_i(t),$$

or, by introducing the average employment outlay ratio of the national economy

$$\gamma(t) = \sum_i \gamma_i \mu_i(t), \tag{7.18}$$

$$\frac{\sum_j a'_{0j}[X_j(t+1) - X_j(t)]}{\sum_j X_j(t)} = \alpha(t)\gamma(t) \tag{7.19}$$

The left hand side of (7.19) indicates the increment of total employment from one unit period to the next in relation to the value of the gross national product in the initial unit period. Let us write,

$$a_0(t) = \frac{\sum_j a'_{0j} X_j(t)}{\sum_j X_j(t)}, \tag{7.20}$$

i e , the average employment coefficient of the national economy. Substituting this into (7 19) we obtain the rate of increase of total employment from one unit period to the next,

$$\frac{\sum_j a_{0j}[X_j(t+1) - X_j(t)]}{\sum_j a'_{0j} X_j(t)} = \frac{\alpha(t)\,\gamma(t)}{a'_0(t)},$$

or, denoting the left hand side by $\rho(t)$,

$$\rho(t) = \frac{\alpha(t)\,\gamma \cdot (t)}{a_0(t)} \tag{7 21}$$

Thus we find that the rate of increase of total employment is the product of the rate of investment and the average employment-outlay ratio divided by the average employment coefficient of the national economy.

The total employment in unit period t is related to the total employment in the initial unit period $t_0 (t_s > t_0)$ by the formula

$$\sum_j a_{0j} X_j(t_s) = \prod_{t=t_0}^{t_s} \left[1 + \frac{\alpha(t)\gamma(t)}{a'_0(t)} \right] \sum_j a_{0j} X_j(t_0). \tag{7 22}$$

Comparing (7 21) with (7 9), we can establish a relation between the rate of increase of employment and the rate of increase of gross national product Denote by $v(t)$ the ratio of these two rates, i e.

$$v(t) = \frac{\rho(t)}{R(t)}, \tag{7.23}$$

we have

$$\varepsilon(t) = \frac{1}{\alpha'_0(t)} \cdot \frac{\gamma(t)}{\beta(t)}; \tag{7.24}$$

i e., this ratio is proportional to the ratio of the average employment-outlay ratio and the average output-outlay ratio.

Total employment grows faster, equal or slower than gross national product according as to whether

$$\frac{\gamma(t)}{\alpha'_0(t)} \gtreqless \beta(t) \tag{7 25}$$

However, $\gamma(t)$ and $\beta(t)$ are averages depending on the structure of the total investment outlay Remembering (7 8) and (7 18) we have

$$\varepsilon(t) = \frac{1}{\alpha_0(t)} \frac{\sum_i \gamma_i \mu_i(t)}{\sum_i \beta_i \mu_i(t)}. \tag{7 26}$$

Since the coefficients γ_i and β_i are determined by technological conditions and $\alpha'_0(t)$ is determined by the employment coefficients α'_{0i} and by the way the national product is composed of outputs of the various sectors, $\varepsilon(t)$ can be influenced only by a proper choice of the structure of investment fractions $\mu_i(t)$

In order to obtain the greatest rate of increase of national income (or of gross national product) the structural fractions $\mu_i(t)$ have to be chosen so as to maximize the average overall output-outlay ratio $\beta(t)$ In order to achieve this, investment outlays must be composed of products of the sectors with the highest overall outlay ratios, β_i

In order to obtain the greatest possible rate of increase of total employment the structural fraction $\mu_i(t)$ have to be chosen so as to maximize the average employment outlay ratio $\gamma(t)$ This requires that the investment outlays be composed of products of the sectors with the highest overall employment outlay ratio γ_i

These considerations refer to the rate of increase of gross national product or of total employment in a given unit period t If the goal of the policy is to obtain the greatest possible increase of total employment after a longer period of times an additional factor has to be brought into consideration. From (7 21) we see that the rate of increase in total employment is proportional to $\alpha(t)$, i e.,

the rate of investment in the unit period The rate of investment, however may depend on the national income, because an increase in national income makes it possible to have a greater rate of investment

Consequently, it may be possible to obtain in the long run a greater increase in total employment by allocating investment outlays not in a way which produces immediately the greatest rate of growth of total employment but in a way which produces the greatest rate of increase of national income The slower rate of increase of employment in the earlier period is then over-compensated by a more rapid rate of increase of employment in the later period due to an increased rate of investment

For instance, let

$$\alpha(t) = cI(t), \tag{7 27}$$

where $I(t) = \Sigma x_j(t)$ is the national income in unit period t and c is a factor of proportionality $(0 < c < 1)$ Then,

$$\rho(t) = \frac{cI(t)\gamma(t)}{a'_0(t)} \tag{7 28}$$

Taking into account relation (7 14), we find that in any given unit period $t_k (t_k > t_0)$ the rate of increase of total employment is

$$\rho(t_k) = c\,\frac{\gamma(t_k)}{a_0(t_k)} I(t_0) \prod_{t=t_0}^{t_k} (1+r(t)), \tag{7 29}$$

where $I(t_0)$ is the national income in the initial unit period t_0

Thus the rate of increase of total employment in any given unit period is proportional to the increase of national income which took place between the initial unit period and the unit period under consideration

In expression (7 29) $\gamma(t_k)$ depends on the values of the investment structure fractions $\mu_i(t_k)$ $(i = 1, \ldots, n)$ in unit period t_k whereas $r(t)$ depends on the values of the allocation of investment structure fraction $\mu_i(t)$ in all the unit periods from t_0 to t_k This can be seen immediately from the formulae (7 8), (7 15), and (7 18). A change of the values of the investment structure fractions in each

period from t_0 to t_k thus produces a change in the rate of increase of total employment in unit period t_k equal to

$$d\rho(t_k) = \frac{c}{a'_0(t_k)} I(t_0)\Big[\prod_{t=t_0}^{t_k} (1+r(t)d\,\gamma(t_k)+\gamma(t_k)d \prod_{t=t_0}^{t_k} (1+r(t)) \Big] \quad (7\,30)$$

The change is positive, zero or negative according to the sign of the expression in braces on the right hand side, i.e., according as to whether

$$\frac{d \prod_{t=t_0}^{t_k} (1+r(t))}{\prod_{t=t_0}^{t_k} (1+r(t))} \gtreqless - \frac{d\gamma(t_k)}{\gamma(t_k)} \quad (7\,31)$$

The left hand side of (7 31) can be written in the form

$$d \log \prod_{t=t_0}^{t_k} (1+r(t)) = \sum_{t=t_0}^{t_k} \frac{dr(t)}{1+r(t)}$$

Hence, the expression (7 31) becomes

$$\sum_{t=t_0}^{t_k} \frac{d\,r(t)}{1+r(t)} \gtreqless - \frac{d\gamma(t_k)}{\gamma(t_k)} \quad (7\,32)$$

Let us start with values of the investment structure fractions which in each unit period from t_0 to t_k maximize the average employment-outlay ratio $\gamma(t)$. Then change these fractions so as to maximize $r(t)$. In each unit period $dr(t) > 0$ and $d\gamma(t_k) < 0$ (except in the trivial case when $\gamma(t) = \beta(t)$ in each unit period, in which case $dr(t) = 0 = d\gamma(t)$). Thus the left hand side of (7 32) increases monotonously with the value of t_k. By choosing t_k large enough it is possible to make the left hand side in (7 32) greater than the right hand side, i.e., to achieve a greater rate of increase of total employment than would be the case if the investment allocation fractions were chosen so as to maximize in each unit period the immediate effect on total employment.

Total employment in the unit period $t_s (t_s \geqslant t_k \geqslant t_0)$ is according to (7 22)

$$\sum_j a'_{0j} X_j(t_s) = \prod_{t_k=t_0}^{t_s} [1+\rho(t_k)] \sum_j a'_{0j} X_j(t_0) \quad (7\,33)$$

Taking logarithms, we find

$$d \log \Sigma_j a'_{0j} X_j(t_s) = \sum_{t_k=t_0}^{t_s} \frac{d\rho(t_k)}{1+\rho(t_k)} + \text{constant} \qquad (7.34)$$

As we have seen, a change of the investment structure fractions designed to maximize $r(t)$ in each unit period leads to $d\rho(t_k) > 0$ from a certain unit period onwards Beginning with that unit period the right hand side of (7 34) increases monotonously, with the value of t_s By choosing t_s large enough it is possible to make (7 34) positive i e ,, to make total employment larger than would be the case if the rate of increase of national income were not maximized in each unit period

Denote by t_e the critical value of t_s at which the expression starts becoming positive Over planning periods which are shorter than $t_e - t_0$ the greatest possible total employment is obtained by composing investment outlays of products of the various sectors of the national economy so as to maximize in each unit period $\gamma(t)$ by using always products of the sectors with greatest employment-outlay ratios Over planning periods exceeding $t_e - t_0$ the greatest possible total employment is obtained by maximizing in each unit period $r(t)$, i e , by composing investment outlays always of products of the sectors with the greatest output outlay ratios

More complicated conditions for the structure of investment outlays are obtained when the principal goal of the policy, i e greatest possible increase of national income or of total employment during a period of time, is subject to additional conditions imposed like, for instance, a certain predetermined rate of growth of consumption Such problems can be solved on the basis of the relations established in this paper by means of the techniques of linear programming

23 *March*, 1956

THE ROLE OF SCIENCE IN THE DEVELOPMENT OF SOCIALIST SOCIETY*

THE Polish Academy of Sciences enters the second decade of its existence at a time when the country is embarking on the realization of a long-term twenty-year plan of economic and social development Work on the plan has not yet been completed, many details remain to be filled in, and the plan will certainly undergo more than one modification as a consequence of experience gained in the course of its implementation. Still the main outlines of the plan are ready, and to them are adjusted both the present five-year plan and our practical economic activities The prospects opened up by the plan are great It provides, in the course of twenty years (the year 1960 being taken as a basis for comparison), for an approximately five-fold increase in industrial production, a close on two fold increase in agricultural production, and an approximately four-fold increase in national income This implies an average yearly rate of growth of about 8 5 per cent in industry, of more than 3 per cent in agriculture, and of more than 7 per cent in national income

The execution of the plan will result in a further change in the country's economic and social structure Industry and building will account for some 76 per cent of national income, as compared to the present figure of 58 5 per cent, while the percentage of the population gaining a livelihood in agriculture will be reduced from the present 38 per cent to 28 The consumption fund per inhabitant —and Poland's population will by 1980 have grown to almost 39 million—will increase by about 175 per cent to amount to about 27,000 zlotys, as against 9,500 zlotys in 1960 (all in comparable 1960 prices) This means an annual rate of consumption growth of over 5 per cent In this connection a major change of consumption patterns is anticipated a reduction in the share of food from 52 to 35 per cent, and an increase in the share of durable consumer goods, furniture and household equipment from 8 to almost 17

* Address delivered by Oskar Lange at the General Assembly of Members of the Polish Academy of Sciences on May 19, 1962

per cent It is anticipated also that in the twenty-year period some 22 million apartment rooms will be built, which will result in an appreciable reduction of the number of persons per room—both urban and rural Working hours will probably undergo major cuts

Poland's international standing will increase considerably. Foreign trade will be multiplied by more than four, and in 1980 half of the exports will consist of machinery, means of transport and industrial equipment The merchant fleet will grow from 709,000 to 4,500,000DWT and the country's own vessels will carry between 50 and 60 per cent of the goods handled by Polish ports as compared with the present less than 25 per cent

The objective of the long-term plan is to close the gap which separates us from the most highly industrialized countries, especially those in Western Europe While we do not know what will be the rate of development in those countries, it is to be expected that it will be slower than ours Compared to the present levels of *per capita* industrial production in West European countries, we expect to exceed by over one-half present British standards, and by some three-quarters those of the German Federal Republic

Science will have a major role to play in the realization of the long term plan We should take a four-fold increase in the numbers of scientific staff as a guiding figure The increase in employment in industry is estimated at some 80 per cent hence the share of scientific workers in the overall employment figure will grow substantially It is estimated that outlay (including investments) on scientific research will increase at least seven-fold This means that the outlays per every scientific worker will be almost doubled Obviously, higher education will have to extend its activities to a corresponding degree, there will be a comparable rise in the number of both students and lecturers

It can be seen that the plan is at once far reaching and ambitious Similar plans for the next twenty years have been worked out also in other socialist countries They all centre on the great plan for the construction of the foundations of a communist society in the U.S.S R adopted by the Twenty-second Congress of the Communist Party of the Soviet Union That plan provides for the economic standards of the Soviet Union to equal within the first decade

those of the United States, hitherto the most highly industrialized country in the world, and in the following decade to surpass those standards considerably The implementation of the Soviet long-term plan, as of the long-term plans of other socialist countries including Poland, will bring about a decisive and irreversible change in the alignment of forces in the world—a change in favour of socialism

The might of socialism will make a new world war impossible once and for all The elimination of the danger of a world war—such as is now a possibility mobilizing million of people for struggle—will have then become an irreversibly accomplished fact

Such are the prospects The very fact that we link them with the implementation of a plan—or a series of plans—indicates that their realization will not be the result of uncontrolled spontaneous development It will be rather the product of objectives consciously set and of activity consisting in a suitable selection of means leading to the achievement of those objectives Such purposefully planned and consciously realized development is a hallmark of socialist society.

In the social formations which preceded socialism, the process of the achievement of human mastery over nature occurred spontaneously, from the point of view of human intentions, it was fortuitous And even more spontaneous and unintended—in fact often quite contrary to human will — were the social effects of this process The development of human society was a process independent of human will, it was a result of social forces outside human control and opposed to man—an allegedly superhuman power Man did not grasp and understand the action of those forces, or he did so in an illusory way, by enshrouding them in various kinds of metaphysical mystification

Socialism has changed the character of the process of social development Under socialism, social development acquires a purposeful and conscious character—of organized social activity of men, aimed at the effective realization of definite ends. An expression of this is the planning of economic and social development

The transformation of social development from a spontaneous and unconscious process into one purposefully and consciously directed

by man is the pivot of scientific socialism. Frederick Engels expressed it in the following words:

> "The forces operating in society work exactly like the forces operating in Nature blindly, violently, destructively, so long as we do not understand them and fail to take them into account. [.] But once their nature is grasped, in the hands of the producers working in association they can be transformed from demoniac masters into willing servants It is the difference between the destructive force of electricity in the lightning of a thunderstorm and the tamed electricity of the telegraph and the arc light, the difference between a conflagration and fire in the service of man "[1]

It is in effecting this transformation that the historical significance of socialism as a social system consists Under socialism, to quote from Engels again,

> "Men's own social organization which has hitherto stood in opposition to them as if arbitrarily decreed by Nature and history, will then become the voluntary act of men themselves The objective, external forces which have hitherto dominated history, will then pass under the control of men themselves It is only from this point that men, with full consciousness, will fashion their own history, it is only from this point that the social causes set in motion by men will have, predominantly and in constantly increasing measure, the effects willed by men "[2]

Such is the vision of scientific socialism. It is a vision of social development directed with the aid of a scientific understanding of the laws governing the processes of nature and of man's social life Socialism elevates science to a novel position—the position of the principal instrument serving in the direction of social development Science never enjoyed such a position in any of the earlier social systems

[1] Frederick Engels, *Herr Eugen Duhring's Revolution in Science (Anti-Duhring)* International Publishers, New York, 1939, p, 305,

[2] *Ibid*, pp. 309-310

The role of science in the shaping of socialist society is three-fold: it consists in the shaping of productive forces, of the economic basis, and of the political and cultural superstructure of socialist society.

The role of science is immediately apparent in the shaping of productive forces—of what we usually call the material and technical foundation of socialist society This role falls in the first place to the natural and technical sciences, but also to a certain degree to the social sciences inasmuch as they deal with problems of efficient organization and management of production processes. An important contribution is made by medicine and pedagogy, which raise the efficiency and skill of human labour, extend the range of its potentialities The role of those sciences as a factor shaping the development of productive forces dates back to capitalism, since it was under capitalism that modern technology, based on a scientific understanding of the laws of nature, was born; it was also under capitalism that modern methods of organizing productive enterprises and of rational calculation of production outlays and results were evolved However, under capitalism, all this was subordinated to the private objectives of individual capitalist enterprises, to the aim of private profit

The absence of an all-embracing social objective makes planned development of productive forces impossible in capitalist economy. In recent times some efforts are being made to plan the development of science and technology—partly under the impact of the planned development of productive forces in the socialist countries and as a consequence of the need of competition with the socialist system However under capitalism this generally means planning within the framework of individual enterprises or business concerns only, such elements of planning on a national scale as exist are rather restricted to the development of the theoretical foundations, introduction into practice is left to the private initiative of business concerns and enterprises As a result, the development of productive forces continues to be spontaneous

It is only socialism which enables a truly planned development of productive forces Such development does not come at once; it is a gradually ripening fruit of, on the one hand, the formation of

socialist relations of production and the organization of socialist production, and on the other, of the experience gained in planning the development of science and technology and their practical applications This is a process beset with many difficulties The main source of such difficulties lies in the historical fact that the first socialist societies were established in countries less developed economically, countries where the process of industrialization took place only under socialism In these circumstances in the course of planning the development of productive forces, these countries have had gradually to acquire the experiences of the old capitalist industrial countries, while at the same time developing new methods peculiar to the socialist system However, those difficulties disappear as the socialist countries reach the level of countries highly industrialized, the superiority of socialist planned direction of the development of productive forces then becomes increasingly apparent

The more effectively we plan the development of productive forces, the more important becomes the role of science in this respect As a result, to quote from the programme adopted by the Twenty-second Congress of the Communist Party of the Soviet Union, "science will fully become a direct productive force" This implies a profound change in the social role of those branches of science which are linked with the development of productive forces In earlier times, science was partly linked with the ideological superstructure of the social system in question while being partly—as regards such fields as most of the natural sciences, mathematics, etc —an element of social culture, not necessarily directly linked *with the superstructure of the social system in question* It certainly was never an integral part of society's productive forces It influenced productive forces indirectly by way of its practical applications Now, when some branches of science participate in the conscious, planned shaping of productive forces, they are becoming an integral component of the development of society's productive forces

The economic and sociological sciences are an instrument for shaping the economic basis of socialist society—i e , socialist production relations, their organization and proper functioning Under

capitalism, those sciences were limited to the role of passive observers of spontaneous social processes, frequently—and, in some periods, as a rule—becoming nothing more than apologists for capitalist production relations, with consequent abandonment of their scientific and cognitional functions Only Marxist social science, connected with the working class movement, achieved a true understanding of the objective laws of development of capitalist society, and will influence the course of that development by way of the revolutionary actions of the working class, based on the theoretical analysis provided by that science The triumph of socialism involves new tasks for social science—tasks consisting in the conscious shaping of production relations and of the conditions for their efficient functioning

A new branch of political economy has developed—the political economy of socialism Its task consists in the investigation of the characteristics and regularities of socialist relations of production On this basis, relations of production are deliberately shaped, the purpose being such an arrangement of them —such organizational forms of socialist production—as should make the resulting incentives fully conducive to the development of productive forces Just as in the case of planned development of productive forces, we do not reach this objective all at once We reach it only gradually, as we overcome diverse elements of relations of production together with the stimuli and modes of reaction they engender, inherited from the capitalist past, and as our knowledge and skill in managing the economy grow The study of such problems is the subject of the political economy of socialism, which is assisted here by various branches of applied sociology, and especially by the science of organization of labour The political economy of socialism and the branches of sociology which I have mentioned are as yet young sciences they are maturing gradually along with the socialist production relations in the study of which they are engaged, sometimes lagging behind the practical needs of shaping such relations

Parallel with the shaping of socialist relations of production and the related question of stimuli and incentives for the development of productive forces is the problem of directing the development

of the socialist economy. This results from socialist social development being consciously shaped. It is the subject-matter of the science of planning the national economy, as also of various applied economic sciences dealing with the direction of the various sections or branches of the national economy. All such sciences are intimately linked with the political economy of socialism, concreting the basic results of the latter and applying them in practice.

The science of planning the national economy deserves special attention This is a product of the socialist mode of production as is the planning of the national economy itself. Interest in planning the national economy has been displayed recently also in capitalist countries, and particularly in economically under-developed countries Such interest is a result of the rapid rate of growth of the socialist economy, and also of the fact that the present development of productive forces to an increasing extent bursts the framework of private capitalist ownership and requires planned social direction The need for planning economic development is especially apparent in under-developed countries, which want to overcome their economic and social backwardness

In this connection, some contribution to the science of planning the national economy has been made also in countries other than the socialist, including also the developed capitalist countries. The fragmentary character of planning under capitalism, however, and especially the difficulty of implementing national economic plans in practice in countries where the means of production are privately owned, is the reason why a major part of this scientific contribution cannot find application in such countries Its full application is possible only in a socialist economy.

The development of the science of planning the national economy in the socialist countries shows two distinct stages. In the first stage, the main—and almost exclusive—interest was centred on the question of the internal consistency of plans An increase in steel production requires a proper increase in the output of coal, iron ore and electric power, as also the training of a suitable labour force. An increase in the wage fund requires an appropriate increase in the market supply of consumer goods, while an increase in

financial investment outlays calls for an appropriate increase in the amount of physical means of production The lack of internal co-ordination of various sections of the plan leads to disturbances in the development of the national economy.

Balance accounting is the instrument of co-ordinating plans. Balance-sheets of the national economy and of its parts are used today in capitalist countries also They were first applied in the Soviet Union when the first five year plan was being drawn up Balance accounting as applied to the national economy is more and more often formulated mathematically in the form of sets of equations solved with the help of electronic computers This makes the calculations increasingly accurate, while at the same time enabling them to embrace an increasing range of phenomena

The second stage has begun relatively recently The optimization of plans has now become the key problem The inner consistency of a plan is a prerequisite for its practical feasibility, since otherwise there ensue disturbances in the economic process But the number of plans internally consistent is very great (in theory, infinite) From among them must be chosen an optimal plan—one ensuring the highest degree of realization of the objective set. In the national economy taken as a whole, this objective is the increase in national income In the specific sections of the economy, the objectives are much more detailed—for example, the minimization of the cost of production or transport, or the maximization of the output of an enterprise or an industry The problem of optimization has become the subject-matter of a separate science, the theory of programming and operations research—a science, incidentally, which finds applications not only in economic research Also this science first emerged in the Soviet Union, and later was developed in the West Only under socialism can it be applied in the planning of the national economy as a whole

The possibility of applying in practice the theory of programming in the planning of national economy did not arise until the introduction of electronic computers Such computers constitute a technical revolution which has deeply affected the science and practice of planning the national economy. This revolution has enabled the development of balance accounting and the wide

application of the calculus of programme optimization, which it would not be possible to apply in practice without computers. We see here how the development of technology not only *influences productive forces, but also makes possible a perfectioning* of the planning and management of national economy

Efficient planning and direction of the national economy requires knowledge of the numerical value of various parameters, such as the norms of outlays of various means of production and of labour per unit of output, the norms of investment outlays per unit of growth of output, the elasticity of demand for various consumer goods etc These parameters—called econometric parameters—are determined by means of statistical observation, or directly by way of research in the laboratory or in the workshop Mathematical statistics plays an important role in their calculation The methods of determination of such parameters constitute the subject-matter of econometrics The term planometrics has recently been proposed in connection with its application in national economic planning

Finally, a few words on the role of science in shaping the superstructure of socialist society In this respect, the direct role of science has hitherto been the weakest Whereas we have subjected the relations of production and the development of the national economy to a decisive extent to conscious planned direction, and *whereas we are beginning with increasing effectiveness to direct* the development of productive forces in a planned manner, the development of the superstructure of socialist society continues to proceed to a large extent empirically only, in a spontaneous *ad hoc manner The sociological and legal sciences and the humanities* have a particular role to play in shaping this superstructure

The contribution of the legal and sociological sciences is in the field of shaping the organizational forms and the norms regulating the activities of the state and of individuals living in human society, in shaping the whole complex of interhuman relations

The humanities exert a profound influence on social consciousness Historical knowledge—in the widest meaning of the term, embracing *social, economic and political history, the history of all the expressions* of human culture—produces understanding of the road

traversed by human society in general and by the nation in particular, of the origins of existing social relations, it facilitates the formulation of the objectives which society sets itself Psychology reveals the secrets of human mental processes and helps in shaping the personality of socialist man

Finally, the philosophical sciences—logic, the methodology of science, praxiology and philosophy itself as a generalizing summing-up of the whole of scientific knowledge—develop the ability of rational thought of correct analysis of situations and of clear perception of the structure of means and ends they equip human minds with a scientific world outlook This is indispensable for a society which wants to liberate itself wholly from the blind and elemental forces which dominated it in the past and to become the master of nature and the conscious builder of its own historical fate

The influence of science on the shaping of the superstructure of socialist society however proceeds not only by way of the direct impact of the various specialized sciences No less strong—and indeed even stronger in the present stage—is the general influence on social consciousness of scientific thought of the scientific way of interpreting phenomena Science becomes an increasingly powerful culture-forming agent Science creates a definite cultural and psychological climate which becomes a part of the superstructure of socialist society The main role is played here by the humanities however an increasing influence on this climate is being exerted also by the natural sciences and above all by technological achievements

Of special importance to the shaping of a socialist society—of both its economic basis and its superstructure—is Marxist political, social and philosophical thought Marxist thought has not as a rule been born and developed in the workshops and laboratories of professional scholars It was brought to life and shaped by the vast laboratory of the historical experiences of the revolutionary working class movement and of the construction of socialism Nevertheless, this is scientific thought in the truest meaning of the term Born out of a practice of transforming reality, it generalizes the experiences of that practice for whole nations and on an international scale, it determines general regularities, it analyses concrete

situations and draws conclusions for effective action In the process of shaping socialist society, Marxist thought acquires great importance for the various specialized sciences—and not only for the social sciences and the humanities Generalizing on a national and international scale the experiences of construction of socialism—and in the further perspective also of construction of communism—it lays down the tasks and role of the individual sciences in the process of the conscious and purposeful guidance of social development It becomes the organizer of this historical process

I have presented successively the role of science in shaping the productive forces, the economic basis, and the superstructure of socialist society Various sciences have a particular role to play in those different realms These however, are mutually interrelated, and that is why the influences of the various sciences intermingle I have already recalled how technological developments in electronic computers have affected the planning and management of the national economy The mutual links between the various aspects of life—between the process of mastering nature and that of shaping social relations—are reflected in the emergence and development of sciences the scope of which extends to various spheres, to both natural phenomena and those of social life One such science is mathematics, which at first found its principal application in investigations of nature, but which today makes its presence felt increasingly in the economic sciences and the practice of planning and managing the national economy, in sociology and psychology, and recently also in linguistics The calculus of probability and mathematical statistics are branches of mathematics having especially a wide range of applications This range embraces both natural and socio economic phenomena and finds applications wherever the regularities under study are statistical or stochastic in nature The extending range of applications of mathematics brings to life more and more new branches of it—for example, the theory of games and the theory of rational decision-making

One science, relatively recent but now very rapidly developing, is of special importance to the shaping of socialist society This is cybernetics—the science of controlling complex systems of cause and -effect relationships Similarly to mathematics, with which it is

closely connected, it has an extensive range of applications in technology, biology, economic science and sociology, linguistics and more and more new fields. Like the calculus of probability and mathematical statistics, it studies natural and social processes distinguished by a specific kind of regularity These regularities in which the decisive role is played by what is called feedback of cause and effect and by the automatic regulation and control of the course of processes It is a further development, in concrete and mathematized form, of the basic ideas of the materialist dialectics of Marx and Engels Hence, the particularly close relation between cybernetics and Marxist philosophy

Cybernetics is interested in automatically functioning machines and industrial equipment, in self-regulating biological processes, and in problems of directing and regulating economic and social processes

Cybernetics constitutes the scientific foundation for the automation of production processes Automation is proceeding rapidly in industry, transport and communications, and is beginning to invade even agriculture Automatic self-controlled devices enable the conquest of outer space Automatically operating electronic computers enable the solution of problems, which hitherto exceeded the capabilities of man Mechanization, along with automation, today invades the processing of statistical data, economic information and accounting, the management of production, trade and finances It has reached even to medical diagnosis, the deciphering of texts (to recall only the deciphering of Maya writings with the help of an electronic computer) and translations from one language into another Recently, the construction is contemplated of a machine which would serve for legal classifications and inference

Deserving special attention are studies in what is usually called the general science of organization This science uses the conceptual apparatus of cybernetics and praxiology to deal with material supplied by economic science and sociology, such application aiming at establishing methods of efficient direction of social processes Applications to problems of planning and management of national economy, to the organization of labour in production and distribution (called economic cybernetics), to

administration of the state and of other organizations and to many other fields are obvious

The role of mathematics, mathematical statistics and especially cybernetics, as here referred to, is indicative also of the process of the blurring of the boundaries between the various sciences. The methodological instruments of the various sciences are becoming increasingly similar while at the same time the distinctions between their social functions are disappearing All the sciences have an increasing influence on the productive forces, the economic basis and the superstructure, of socialist society, even though the influence of some particular science on various fields may be more or less direct or indirect

Hence arises the practical need for more and more complex scientific research Research must embrace increasingly extensive ranges of interconnected problems and make use of the instruments of increasingly numerous branches of science—including also the technical sciences Of growing importance are research programmes requiring the co operation of the natural and the social sciences Co operation cannot be limited to various natural or various social sciences Co-operation between the natural and the social sciences, between technology and the humanities, becomes indispensable, while at the same time all the sciences—even though to a varying degree—require the assistance of mathematics, cybernetics and philosophy Such co operation is possible only on condition that research work is collective and planned and that material and technical resources and human energy are concentrated on extensive complexes of problems of key importance to social development

From this there flow far reaching consequences for the organization of scientific research, and also for the training needed by the modern scientist The sharp division between education in the humanities and in the natural sciences is an anachronism, and the frequent discussions in the press, in which the humanities are opposed to the natural sciences or vice versa, are simply irrelevant In socialist society the natural sciences and technology are subordinated to the humanist goals of shaping social relations and social consciousness, while at the same time they serve to create the material and technical basis indispensable for the realization of those

humanist goals. Another anachronism is the link between mathematical and natural science education, on the one hand, and between philosophical, historical and humanities on the other. Now that mathematics and technology are invading the humanities, that the natural sciences and technology pose novel philosophical problems, that technology directly leads to far-reaching social consequences, and that the methods of cybernetics are acquiring an increasingly extensive range of applications in technology and in the direction of social processes, the unity of science becomes fully apparent. The need arises for a novel type of scientific training as also for novel programmes of school education, very much different from the traditional

As a result, novel links will be shaped between the various sciences, novel instruments of research, novel forms of research organization and novel ways of influencing natural and social processes And this will contribute to the increasingly complete realization of the vision of scientific socialism of which I have spoken the vision of a world, in which man will have an increasingly perfect mastery over nature and over the development of his own social life, one in which he will be more and more effectively the conscious creator of his own fate This is the role to which science is called under socialism And alongside such a role, socialist society gives science the means to perform it This role and these means impose a great responsibility on science Today as the Polish Academy of Sciences enters the second decade of its existence, this role and responsibility are well worth being kept in our minds