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The growth of scientific planning in the West

1 Scientific planning

Scientific planning has its origin essentially in econometrics, which is today understood to mean the combined application of mathematical economics and mathematical statistics to statistical data of an economic kind. There is at present a general tendency on the part of economics to move gradually in the direction of sociology, in other words, for economics to profit more and more from the information provided by the more recent and more difficult branches of social studies. This frequently amounts to a refinement of the psychological basis of economics, by, for example, taking the non-material elements in human needs and behaviour into account, and to the introduction into economics of the relations between groups of persons in social life. The inclusion of elements of this kind in econometrics means that this science is gradually tending more and more to become sociometrics, as is bound to be the case.

Even in those cases where, as far as the method that is employed is concerned, the planning calculations strike us as very primitive, they are still essentially a form of econometrics or sociometrics. Even the simplest calculation is ultimately based on assumptions about the relationship between various social phenomena and on giving these a certain statistical form.

The early history of the science of planning in the West is consequently to be found principally in the history of econometrics. I shall therefore precede this short study of the early history of planning by first of all giving a brief historical outline of the three composite parts – mathematical economics, statistical observation and mathematical statistics.

2 The three waves of mathematical economics

There have been three attempts by mathematically trained economists in the history of the science to put the practice of economics on a more exact basis. The first failed, the second did not progress beyond the abstract stage and it was only the third attempt that succeeded in penetrating into the concrete practice of economics.

The first attempt took place in the years that followed the publication of A. Cournot's book, *Recherches sur les principes mathématiques de la théorie des richesses*, in 1838. Although the tradition which was inaugurated by this first attempt has continued in the case of French engineers, the idea certainly did not catch on with economists in other spheres. The clearest evidence that we have of this fact is Cournot's own omission of mathematics from a later edition of his book.

The second 'wave' of dealing mathematically with economics occurred round about the year 1875, when L.Walras' work, *Eléments d'économie politique pure*, appeared. This attempt led to a regular flow of books on mathematical economics from many different European countries. This resulted in a number of closed theories which contributed a great deal to the sharpening of concepts and theses about mathematical economics. This literature none the less remained mainly theoretical and continued to exist to some extent separately from concrete, practical conclusions in the sphere of economics.

The research work undertaken by V. Pareto, who was, among other things, also the founder of the study of welfare economics, made a very important contribution in this sphere. It is also interesting to note that, despite Pareto's own very conservative views, his theory can still be used (provided, of course, that it is suitably brought up to date) as a point of departure for doctrines that are directly opposed to the older liberal way of thinking.

Very important work was also done in England and in the Scandinavian countries, where the study of economics had been flourishing for a long time, but where new social ideas were originating which were thus able to make use of this theoretical machinery. In this connection, the name of K.Wicksell merits special mention.

All this work was, however, strictly theoretical in the sense that it was not based on the measured numerical values of the variables to which it referred.

It was, as I have said, left to the third 'assault' by mathematically orientated economists, which took place round about the year 1930, to establish an empirical connection with economic life. This was the year which saw the foundation of the Econometric Society, the aim of which was to follow the example of the natural sciences in closely relating theory to practical observation of the object of study. This had gradually been made possible by the expansion that had in the meantime been taking place in the sphere of statistical observation (see section 3). Econometrics were therefore defined as the combination of theory and observation, both relying on the help of the exact science of mathematics.

Among the leading pioneers in this field were the Norwegian economist R. Frisch, the English economists A. L. Bowley and R. Stone, the French economists F. Divisia and R. Roy, the American economists C. F. Roos and H. Schultz and the German economist J. Marschak. Among the members of a rather later generation of economists that has more recently made its mark on the study of econometrics we can mention here H. Houthakker, L. R. Klein, R. Solow, T. C. Koopmans, H. O. A. Wold, H. Theil and G. Tintner.

A degree of opposition, however, remained in certain circles of 'literary' economists. This opposition was encountered in its most extreme form in Germany, where attempts were made to 'prove' that mathematics could not, because of its very nature, be applied to human activities. This view was in the main due to a somewhat limited conception of the true nature of mathematics and to an inability to see that arguments of this kind not only deprive the science of mathematical economics of its basis, but that they also undermine the very foundations of economics as a whole, and this was certainly not what these 'literary' economists intended to do.

3 Statistical observation

An activity which went by the name of statistics, and which consisted of expressing certain social phenomena in figures had, of course, already been taking place for several centuries. The word originally related to the use that was made of these figures by the state, in carrying out an administration or a policy. Among the earliest statistical observations that we have are those figures which indicate the size of the population and which were consulted in connection with decisions about military matters and taxation. They were further refined by being broken down into figures showing the birth-rate and death-rate, age-groups and trades or professions, and by the gradual addition of more typically economic figures, such as those relating to prices, harvests, trade, production and transport and communications. In the nineteenth century, figures about various social phenomena, such as unemployment and crime, were developed and a number of statistical year books, containing a great deal of information, came into existence. In the twentieth century, the few sets of production figures that had already been compiled in the preceding century were rapidly extended and work began on statistical abstracts showing the condition of the entire national economy. These included, for example, figures relating to the national income and the national wealth. Statistics, which had originally come about as a by-product of various forms of administrative activities, gradually became more and more independent. Additions were continuously made to the quantity of figures already collected and improvements were made in their quality.

In the 1920s and 1930s it became necessary to follow the fluctuations in the economic situation more and more carefully. This led to a further increase in the number of figures – monthly, weekly and even daily figures were provided in the case of a number of data of central importance in the appraisal of the economic cycle. Methods of analysing the movements of these sets of figures into various components were also developed. This was done especially in order to isolate the seasonal component and the so-called random component, as well as the general trend. What remained was regarded as an indication of the cyclical component.

4 Mathematical statistics

This refinement of the presentation of statistical data was related in the 1920s to a number of methods that were used in the natural sciences and had their origin in the theory of probability, which was already more than a hundred years old. This amounted to dealing with observed figures which were assumed to have been determined partly by numbers that could have been obtained by drawing lots. The relevant components were regarded as random components and the theory of probability had various kinds of machinery at its disposal by means of which these random components could come about, as well as methods of minimising their influence. It was hoped in this way to be able to estimate the 'systematic' components which were attributable to the relationships of which knowledge was really required. What we should say in modern terminology is that, by means of mathematical statistics, models of the creation of these random components were built, with the special aim of diminishing their disturbing influence. These methods were also used in astronomy, physics and biology.

A second important element in mathematical statistics was the assessment of the relationship between the assumed systematic components in each of at least two phenomena present. The relationship, which has even given its name to its geometrical representation in all later applications, was the relationship between the height of sons compared with that of their fathers. It was found that an exceptionally tall father certainly had relatively taller sons than normal, but that the height of these sons did not show such a marked deviation from the average height as that of the father. This phenomenon was called 'regression', and the line on a graph showing the relationship between the height of a son and that of his father was called the line of regression. This word is still used for every line that can be drawn, with the help of mathematical statistics, to show the relationship between two phenomena. In addition, criteria were also developed to measure the degree of conformity present in the movement of two variables. The best known of these is the correlation coefficient.

Mathematical statistics are not limited merely to the study of the relationship between two phenomena. They can also be applied to the study of the relationship between a greater number of 'variables', for example, the relationship reflecting in the best possible way the variations in a given phenomenon with the aid of a linear function of the variations in a series of other phenomena. In this case, we speak of a multiple regression equation, and here too a correlation coefficient expresses how well reality can be explained by theory.

The results obtained from a statistical model of the random components in each of the variables concerned will, of course, vary in accordance with the model chosen. We may, for example, assume that random components will occur only in one of the variables – the variable to be explained, for example – or we may, on the other hand, assume that they occur in all the variables. Another assumption that can be made is that the random component occurring for a certain period in one of the variables is dependent on the random component in the same variable during the preceding period or that the two are independent of each other, and so on.

Whether only one relationship or a greater number of relationships is assumed between a number of phenomena is also of great importance in the application of this method to economics. In the second case, we speak of simultaneous relationships or equations, and the methods used in assessing a set of relationships of this kind are generally different from those used for a single equation. In the use of this method in the economic and social sphere, these simultaneous relationships are the normal phenomenon. When economics had reached the stage of verifying the relationships involved against empirical data, the mathematical statistics that were needed in this process had also to undergo considerable further development. This growth was necessary, partly because the experiment could be applied far less frequently in a social environment than in the sphere of natural science and partly because the disturbing components could less easily be avoided.

5 The rise of econometrics

By the 1920s, it had gradually become possible to test in a rather more systematic way some of the relationships which had been assumed in the theory of economics for more than a century and which were very clearly expressed in the mathematically formulated theories of Walras and those who followed him. Thus, the demand function for agricultural products became an object of testing, although initially only a single relationship between harvest and price, derived from the figures of a series of successive years, was sought. In many cases, a fairly clear negative relationship could be established. This was in fact what the theory had wished to find, and the test was important not only in that it confirmed the theory, but also in that the slope of the line could be determined, that is to say, the numerical extent of the influence of a change in price of a given amount on the quantity demanded could be established. This marked a beginning at least – made, among others, by H. L. Moore in his *Forecasting the Yield and Price of Cotton* in 1917 – in the direction of econometrics. We may say that this movement contained a message both for economists and for statisticians. Economists had to formulate their theses in such a way that they could be verified by observation, that is, as 'refutable hypotheses'. Statisticians, on the other hand, had to investigate meaningful relationships, that is to say, relationships to which a theoretical meaning could be ascribed. It was also possible to regard econometrics as the discovery of the identity of the regression equations from mathematical statistics with the various relationships, such as those of demand or supply, with which theoretical economics worked. It was, therefore, in particular the relationship between the systematic components of the observed statistical series that corresponded with the equations from mathematical economics.

The great increase in the number of statistical observations had in the meantime enabled a whole series of tests to be made and there was a regular flow of studies of this kind. In addition to studies devoted to the relationship between the quantity demanded and the price, which played an important part in agricultural products in particular because of fluctuations in the harvest, there were also many studies of the relationship between demand and income. This was made statistically possible by the existence of the so-called family budgets. On the side of economic theory, the importance of income in determining demand was stressed by the work of J. M. Keynes. As a natural consequence of the existence of both these connections, the need arose to use multiple regression equations.

The verification obtained by the econometric method meant on the one hand that some theories had to be rejected on the grounds that they provided insufficient explanation of reality. On the other hand, however, those theories which were in fact able to explain the real situation could be set out in specific detail, by indicating the numerical values that had to be assumed in the case of a number of coefficients in order to make the degree of conformity as high as possible. It was sometimes possible to regard these coefficients as the elasticities, so popular in economics, either of demand or supply, or of other relationships. A whole series of such determinations of elasticities therefore took place. The income elasticity of the demand for a great number of consumer goods was, for example, estimated. An initial distinction was made between elasticity in the long term and elasticity in the short term. Doubts were raised concerning the influence that could be exerted on the demand for credit by the rate of interest or on the demand for labour by the wage rate.

In the meantime, the great depression had set in. This unintentionally provided a dramatic opportunity for a number of experiments to be carried out in the economic sphere with those national economies that had been affected by the depression. Some experiments were consciously even carried out in the form of hitherto highly unusual methods of intervening in economic relationships. This enabled a rapid increase to be made in our knowledge of economic mechanism.

6 Econometric models for explanation and forecasting

In all this, the interdependence of the various economic and social phenomena had become so obvious that the need arose for a systematically arranged study of a number of simultaneous relationships. It also became clearly necessary, because of the great numbers of variables which characterised economic life and the comparatively modest knowledge of them, to simplify these systems, while at the same time preserving the most essential characteristics.

The term 'economic models' came to be used more and more for these simplified systems. At this period, interest was focused entirely on models which explained the movement of the economic cycle in broad outlines. These models were also in accordance with an empirical approach which was very popular round about this time and which was known by the name of 'economic barometers'. American statisticians, specialising in the economic cycle, believed that they had found that the cyclical waves were displayed on the stock market earlier than on the commodity markets, and on the commodity markets earlier than on the money and capital markets. The price and turnover figures which characterised these markets systematically displayed wave lines in which all the movements of the stock market could be found, with certain delays, again on the other two markets. This 'barometer' of three lines was used for the purpose of forecasting the movements of the two markets that lagged behind the movements of the first market. Greater numbers of lines were subsequently developed, including, for example, the labour market showing a lag behind the commodity markets similar to the money and capital markets.

None of this, however, had any foundation in theory. The need therefore arose to construct a model of the causation of the cyclical waves that was theoretically based and at the same time empirically tested. The first models of this kind were published in 1936. They at the same time provided an opportunity of testing the real value of the countless theories about the economic cycle. Under the auspices of the Secretariat of the League of Nations, these theories were classified systematically by G. von Haberler in his publication, in 1937, of *Prosperity and Depression*. Subsequently, a number of works appeared providing many different versions of econometric models of the cyclical movement. These econometric models were characterised chiefly by the fact that: 1 a list was compiled of variables occurring in the model, 2 a list was compiled of equations expressing the relationships between these variables, and 3 the coefficients occurring in these equations were obtained by statistical verification against observation, in which the aim was to achieve as high a degree of conformity as possible between reality and theory. The usefulness of these models can be seen, on the one hand, in the insights that they provided concerning the forces that played the most important part in the cyclical movement and, on the other hand, the opportunity that they provided for forecasting economic development in the short term.

It thus became apparent that a central part was played in economic fluctuations by the total demand for goods and services, a demand which may be regarded as being composed of the demand for consumer goods and the demand for investment goods, each divided into private and public demand. In this connection, it was especially the demand for investment goods that was seen to possess a certain degree of autonomy and to have a propensity to carry the other variables of economic life in its wake. Replacement investment, investment made on a basis of new possibilities of production and public investment must be included among these more or less autonomous elements. In addition, investment was also realised to be influenced by the prior development of the demand for all goods and of the possibilities of financing. Consumption expenses were seen to be determined to a far greater extent by the income of the immediately preceding period and consequently to be far more the result of other variables than their cause. It was also realised that the price level of goods and services was conditioned far more by the demand for goods than by the supply of them, with the exception of the prices of harvest products. These also showed (opposite) random components because of the random fluctuations that occurred in harvest yields. Finally, the influence of credit, interest and wages policy on economic fluctuations was seen to be of a secondary nature, although complications did occur whenever there was a great deal of speculation either in goods or in stock.

Although the West has been successful in preventing the occurrence of extreme fluctuations in the economic cycle since the Second World War, partly because of the experience gained at the time of the great depression, economists have continued to draw up models of short-term economic development in order to be able to explain and forecast the movement of the economic variables. These models are now able to forecast these movements in a much more satisfactory manner than the primitive methods of, for example, extrapolating recently observed movements which had previously been the only available means of forecasting. A really reliable forecast is, however, still impossible because of the chance character of several important elements, such as the harvests of certain important agricultural products and political events.

A very accurately planned project for the construction of a model explaining and forecasting short-term fluctuations in the American national economy is at present being carried out by a large group of econometricians from various universities. The team includes J. S. Duesenberry, G. Fromm, L. R. Klein and E. Kuh.

7 Econometric models for economic policy decisions in the short term

Models designed to explain and forecast the movement of the economic cycle can also be put to a different use, namely, for the purpose of choosing between alternative measures so as to influence short-term economic development. In order to assess the results of a definite change in economic policy, different figures have to be chosen for the values of certain instruments of economic policy. In this way, it is possible, for example, to assume that the government will spend more or less or will raise or lower taxes, or that the Central Bank will change its rate of discount. These variables will take their place in the model among the 'data'.

What an operation of this kind in fact means is that the traditional problem of explaining or forecasting the economic event is partly reversed. In this case, an event that is regarded as desired is assumed and the question is asked as to what values have to be given to a number of variables which are subject to government control. A special term is used to indicate this changed problem – whenever it is a question of solving policy problems of this kind, we speak of 'decision models'. It is not entirely satisfactory that these models should be called by a different name, since they may in principle remain exactly the same as before, that is to say, they may include the same equations. All that the different problem means is that a different role is assigned to the variables – some, which were previously regarded as given – that is, the instrument variables – are now assumed to be unknown, whereas others, which were previously unknown – that is, the so-called target variables – are now regarded as given. The latter are the variables which are regarded as determining the well-being of the population. In the period following the Second World War, these were, in several countries in the West, employment, the surplus of the balance of payments, the level of investment, the distribution of the national income among employees and self-employed persons and the price level. If these variables are all regarded as given in advance, we speak of a policy with fixed aims. It is also possible to pursue a different course of action, namely by aiming to achieve a maximum of one or other 'welfare function' with the instruments of economic policy available. In this case, we speak of flexible aims.

The method that I have just described was applied after 1945 in various countries in the West to the preparation of short-term economic policy and may therefore be regarded as an example of planning. This was, however, a case of planning a macro-economic policy, with the principal purpose of adjusting the national economy to short-term changes in the environment. But the aims of the volume of investment and the distribution of income also represent elements of policy in the longer term. In this short-term macro-economic planning, however, we have to see a means of access to a more detailed form of planning with aims in the longer term. What is more, we should not forget that every country, even a developing country, needs to pursue a policy of annual adjustment to circumstances. The knowledge acquired in building models of the kind just described is therefore especially useful in the carrying out of long-term plans, because here it is frequently a question of guiding the economy in the bridging of a gap between the desired development and the development that is really taking place.

One of the first institutions to go over to the building of a decision model of this kind was the Central Planning Office of the Dutch government. A recent form of the model used was published in the Central Economic Plan of 1961.

8 Models for long-term development: macro-models

The development of economies in the West over periods of more than a few years had, of course, long been studied by many of the classic authors in the field of economics, but specifically econometric models were not built until the science of econometrics had come into existence. Here too, the availability of statistical material played an important part and an encounter had to take place between theory and empirical observation. The latter had been focused on the calculation of the so-called trend movement of a number of series of figures relating to economic phenomena. Once again, the bridging of the gap between observation and reality was dependent on the availability of macro-economic series, such as those relating to the national income, the total stock of capital goods and so on.

It was also easiest to formulate a theory for a macro-economic problem which had in the first place an analytical purpose, in other words, which aimed to explain the observed course of events. A closed model for explaining this observed trend was tested in 1942. This model emphasised aspects that were different from those stressed in models of the short-term trend. On the one hand, certain aspects of the short-term movement, such as the chance fluctuation of harvests or of stocks, are not very important in explaining long-term development. On the other hand, however, the development of population, technical development and the creation of capital are very important in this respect. Technical development shows itself in at least two ways – by mechanisation, in which human labour is replaced by machines, and by better organisation and new discoveries, by means of which an application of the same amount of labour and capital leads to production at a higher level than before. In the original model, special attention was devoted to the forces of growth listed for this purpose and an attempt was made, with the help of this knowledge, to assess the influence of the growth of the population, the creation of capital, mechanisation and the increase in technical knowledge on the growth of production and employment.

Several of these influences were more accurately analysed in later models and studies. The possibility of replacing labour by capital was the subject of many studies. Others were devoted to distinguishing between the increase of knowledge on the part of the experts and that on the part of employees, the study of the results of better education on productivity hereby making its first appearance.

Once the need for active government policy in the sphere of economic development had become more generally accepted, models were built that were orientated in the direction of government decision; models, in other words, that were aimed at the political problem. The question of the most desirable rate of development thus automatically arose. Very many works dealing with this question have appeared in recent years. In this study, it is also necessary to know the so-called utility or welfare function, which expresses the preferences of the government or those of the population. The central problem here is what sacrifices made in the present are compensated for by a given improvement in the standard of living in the future. Empirical research in this sphere is, however, still in its infancy. Upon certain assumptions, the conclusion has in the meantime been reached that the rate of development of the countries of the West has, in the past, been too slow rather than too fast.

9 Models for long-term development: micro-models

Both the example of the East and the growth of understanding in the West have led to an increase in the importance of development models of a micro-economic kind, in which a distinction is made between a number of sectors or industries in the national economy. The first steps that have made models of this type possible go back to the development of the input-output method of W. Leontief. In this, the relationships existing between various industries, as a result of so-called inter-industrial supplies, are expressed. Almost every industry requires commodities which form the finished product of other industries, and it needs these in proportions that sometimes remain more or less constant for a remarkably long time. Technical changes have sometimes also caused drastic changes to occur in these figures. Another aspect of production technique is that an increase of production in an industry requires a certain amount of capital, and in different industries this increase shows a very divergent ratio to the increase in the net value of the production that is obtained by this means. This is the so-called capital-output ratio, and it has similarly been the subject of a great deal of recent research which has also contributed to the development of micro-planning. Finally, the study of the pattern of spending of consumers with different incomes, differently composed families and different social positions has been a subject of exhaustive 'market analysis'. This too has made an important contribution to increased possibilities of micro-economic planning.

In these points, a certain measure of agreement has gradually been found with the planning methods used in the East. The input-output method has, of course, been in use there for a long time, under the name of the 'method of material balances'. It was, however, only in the more recent past that a beginning was made in the East on work with patterns of consumption on the part of consumers. With regard to capital-output ratios, economists in the East have tended to go their own way as far as definitions are concerned, but here too the methods used come essentially very close to each other.

The most recent development in models for planning is undoubtedly to be found in those spheres that are described in the West as social rather than as economic in the narrower sense. By this are meant education, medical care, the provision of housing, social consultation and so on, and the influence of the level of consumption on productivity can to some extent also be included under this heading. It is only recently that it has become clear that these social components of well-being have an influence on productivity that cannot be neglected and that they have consequently to be integrated into economic planning. To an increasing extent, the results of various studies are becoming available, and these form the basic material of this kind of more general planning and can thereby help to promote the fusion of economic policy (in the older sense) and social policy. This has been made possible only because more and more social components are gradually coming to be measured – and this, of course, is a mark of the progress of the scientific method in the field of the social sciences.