CHAPTER 2

ECONOMIC MODELS

2.1. Scope of Models

2.11 As we already observed (§ 1.2), the way in which certain means of economic policy influence the economic situation depends on how citizens and institutions react (i.e. adapt themselves to the new data) and this behaviour is represented by the economic relations, or equations, which together form an economic model. The word "model" also indicates that the assumptions made about the nature of this behaviour are explicitly stated and that they are in many respects a simplified picture of reality. These assumptions are partly of a "natural" character, partly of a technical or legal, and partly of a psychological character, as has already been shown in brief. Together they specify the foundation and structure of the economy considered. Such specification has always to be a simplification because of the very complicated nature of economic life. As a rule, only a few of the most relevant characteristics of society are implied.

Exact specification is necessary to avoid confusion and misunderstanding, for, on the basis of such specification only can the economist put precise questions and try to give precise answers. Problems of practical policy have therefore to be interpreted in terms of such simplified models and, after the analysis has been made, an interpretation back (i.e. an application of the findings of the model back to the real situation) has to be attempted. Here, of course, divergencies of opinion may, and necessarily will, arise. It is an initial advantage for mutual understanding, however, if concensus of opinion can be obtained on the precise problems and answers constructed with the aid of the models; this helps to narrow down differences of opinion. And if somebody believes that model A does not fairly represent the actual situation to be discussed, he will be forced to indicate in what respect that model has to be changed. For the revised model, the problem can be considered anew.

2.12 Since a model has always to be a simplified picture of reality, and reality may widely differ from one situation to the other, it follows that there will have to be made many different models, each of them meant to focus on certain aspects of economic life. Accordingly, there is a great variety of models. Some categories may be mentioned. There are, on the one hand, *micro* models, in which a large number of "compartments" is assumed to exist (e.g. firms and households) and where, for example, a distinction is drawn between a large number of different goods. On the other hand there are *macro* models where such distinctions are not made, but certain features common to all compartments are considered, perhaps in more detail than would otherwise have been possible. There are models for *closed* economies (economies without international trade) and for *open* economies (with such trade). Still another distinction is that between *static* and *dynamic* models. Here the line of distinction is chosen differently by different authors. We will call a model dynamic only if, in one or more of its relations, economic variables occur which relate to different time periods. Most of our policy models will be static. This implies that for this year's situation this year's variables only are relevant, there being no variables referring to earlier dates or, if we use a quarter as a time unit, only this quarter's variables are relevant for this quarter's situation. This heavy simplification may be acceptable if the time units we are using are long ones, that is, if we are interested in long-term equilibrium. It is also acceptable in another situation, however: if we are only interested in what happens in the next time period, as is the case in short-term policies (including year-by-year policy decisions). In that case all economic variables referring to previous time periods are already known and may be considered as given. For this reason the model for the next time period, only, will be static in character, according to our definition, even if reactions are influenced by the previous values of economic variables.

2.13 A complete description of a model requires an enumeration of a large number of details; and hence a systematic survey of all conceivable models (indicating, for each detail, what other choices could have been made) is difficult. We will not therefore try to give a systematic survey, but we will mention some of the "details" or features in

order that the reader may have some basis for judging models that will be presented to him.

2.14 Important features seem to be, first of all, a certain number of details about the "*actors*" (the acting firms, households or other entities) entering into the model:

(*a*) Their *number*, defining the degree to which the model is micro or macro in character. We will repeatedly work with only one or two actors, namely the combined private firms and households as one ("aggregated") actor and, perhaps, the state as the other.

(*b*) The *nature and behaviour of their income:* from what sources does it originate and how does it react to certain other phenomena? If one of the actors is "all wage earners", its income is payment for labour supplied: we need to know, how do wage earners react, as regards their supply of labour, to the wage rate? If an actor is a producer of goods, how does he react to changes in their price?

(*c*) *Spending habits:* what part of income of the actors is spent, what is left unspent (hoarded); what part of it is spent on investment, what on consumption; how is consumption expenditure distributed over various goods, if there are more than one?

(*d*) *Nature and origin of wealth:* Is it assumed that the actors are in the possession of wealth, or assets? Are they liquid or non-liquid assets? How does this wealth come into existence: by savings, or by value increments?

(*e*) *Investment habits:* how do the actors invest their savings, and how do they react to changes in prices and yield of assets?

2.15 Another set of details concerns the *markets* occurring in the model, and hence at the same time the goods handled at these markets.

(*a*) *Number.* It depends again on the degree of aggregation whether only a few, or many, markets are assumed; they may be markets for final commodities, for intermediate products and for factors of production (e.g. labour).

(*b*) *Stock or flow character* of commodity handled: is the market considered a market for the flow per time unit produced and exchanged, as it must be in the case of a non-durable commodity; or is it a market where the total stock of a commodity, whether produced recently or at some previous time, is handled? For durable commodities, including

liquid assets, this is the more relevant market for somewhat longer time units: the price of new securities is not independent of the price of already existing ones.

The further details concerning markets, such as the elasticity of demand or supply are, in essence, already included in the details about the actors.

2.16 A third class of characteristics has to refer to the *technical relations* (including legal or institutional ones) involved:

(*a*) *Number* of each type: how many production relations, how many tax relations?

(*b*) *Nature of phenomena involved:* is one equation assumed to exist which tells us how much product will be obtained out of given quantities of factors of production (e.g. how much nitrogen monoxide is obtained from given quantities of nitrogen and oxygen); or is there one relation for each factor of production which tells us how much of that factor is needed to produce a given quantity of the product (e.g. one equation indicating how much sulphur is needed to produce a ton of sulphuric acid, one other telling us how much hydrogen is needed and a third one for the oxygen needed)? As is well-known, there are two alternative methods of describing the production process, corresponding fairly well to the situations prevailing in chemistry if the reaction is, respectively, an equilibrium reaction or a one-sided reaction.

(*c*) *Mathematical shape.* The relation between product and factor may be one of proportionality or one of decreasing returns, and so on. The relation between income and income tax may be less or more progressive, etc.

2.17 As has already been observed, the enumeration is not easily made a complete one. The list just given is by way of example only, but making it sufficiently clear, that there is a very large number of possible models.

A model will be represented most accurately by (i) a list of phenomena and variables distinguished, and (ii) a system of *mathematical equations*. Each of these equations contains a certain number of the unknowns and a certain number of the given variables and constants. Not all the unknowns need occur in every equation, but they may. If all of them occur in every equation, we may say there is complete

interdependence. No single one can be determined independently of the others. But there may be other logical structures, such as that in which each equation contains only one unknown. Each unknown can then be determined independently of the others: this means that the constants that do not occur in the one equation containing a certain unknown do not influence that unknown. Suppose the unknowns are x_1 and x_2 and the given quantities are indicated by a's and b's, while the equations are:

$$a_{11}\,x_1 = b_1 \tag{1}$$

$$a_{22}\,x_2 = b_2 \tag{2}$$

then x_1 is not influenced by b_2 or a_{22}. If, however, as in the previous case, x_2 had also occurred in the equation (1), and x_1 in equation (2), e.g.

$$a_{11}\,x_1 + a_{12}\,x_2 = b_1 \tag{1'}$$

$$a_{21}\,x_1 + a_{22}\,x_2 = b_2 \tag{2'}$$

then x_1 is now also influenced by b_2 and a_{22}.

Still another, and interesting, logical situation is the one where x_1 occurs in the second equation, but x_2 does not occur in the first:

$$a_{11}\,x_1 = b_1 \tag{1''}$$

$$a_{21}\,x_1 + a_{22}\,x_2 = b_2 \tag{2''}$$

Now we say there is a certain "causal ordering" [1]; meaning that x_1 is independent of what occurs in equation (2''); but x_2 is not independent of what occurs in equation (1'') and may be said to depend on x_1. In a way, therefore, x_1 may be said to cause x_2, and not the other way round. The values of x_1 and x_2 may be found in succession and their determination can be easily explained in ordinary speech. This difference in logical structure has some practical consequences to be discussed later. It should now be clear that the type of logical ordering shown in a model may be different, for the problems of economic analysis, than it is for the problems of economic policy, since the unknowns are not the same set in both cases. (Cf. §§ 4.22 and 4.23).

[1] Cf. Herbert A. Simon, "Causal ordering and identifiability," in Studies in Econometric Method, ed. by W. C. Hood and T. C. Koopmans, Cowles Commission Monograph Nr. 14, New-York–London, 1953, p. 49.

2.18 The solution of a problem in economic analysis, as well as of a problem in economic policy, consists, in principle, of the solution of the unknowns of the whole system of equations which together form a model. The unknowns differ for different problems, a point which will be illustrated by many of our "problems" (cf. appendix 2). The advantage of working with models represented by sets of equations lies in the decomposition of the process of research into logically arranged elements, facilitating its being checked. The somewhat loose talk about direct and indirect "effects" of a certain measure of economic policy, usual in verbal analysis, may easily forget one or several of these effects. In the system of equations no such oversight is possible. In addition every "effect" of whatever order can be traced and localized, and its influence determined.

2.2 Some Conclusions from Models

2.21 In a sense it can be maintained that all economic reasoning has been based, and must be based, on models. All economic theory may therefore be classified as "conclusions from economic models". If we are here formulating some of them, in a very brief way, we are confining ourselves to those portions of economic analysis that seem to us to have a particular importance for economic policy. There are two types of conclusions from models; one refers to models that are completely aprioristic in nature and the other refers to models in which statistical material has been used, that is, to models that, on being tested statistically, have (in some way or another) proved successful.

2.22 Propositions derived from aprioristic models have been proved to be dangerous, primarily because so many aprioristic models are not realistic. The assumptions on which they rest must therefore always be borne in mind.

One of the very important conclusions drawn from economic models is what might be called the *optimum proposition of free exchange.*

Several attempts have been made to prove that some sort of optimum situation will be reached if the organization of production and distribution is based on perfect competition, or, in the practical terminologies often used, free enterprise and free pricing. It can indeed be

shown [1] under certain conditions to be discussed later, that perfect competition leads to a so-called Pareto optimum. A Pareto optimum is a situation in which it is not possible to increase the utility of anybody without decreasing somebody else's utility. Inversely, any Pareto optimum can be obtained by a process of perfect competition.

The contents of these statements should not, however, be misunderstood, as they often are. The following points have to be kept in mind.

1. There is not just only one Pareto optimum, but there are a large number of them; and a choice between these is only possible if we have some social utility function, which, under certain further assumptions, may be equivalent to having a method of comparing utilities of different individuals. Each of the Pareto optima is characterized by certain income transfers, and the prices resulting for the different commodities will depend on these transfers.

2. It has not been proved that the one particular case where no income transfers take place at all is "better" than the other Pareto optima. On the contrary certain income transfers will even be necessary, if only because firms working under decreasing marginal costs may suffer permanent losses. There are strong further reasons for advocating income transfers.

3. Certain methods of transfer, as, for example, an income tax of the usual type, are, however, not compatible with a Pareto optimum if the only constraints accepted are those required by the necessities of production. [2]

4. Perfect competition without any further specification of economic organization—without a specification of either some income transfers, or other equivalent measures, for example—is not sufficient, therefore, to define the organization of society, and thus it cannot be said to lead to an optimum.

5. According to 1 and 4 some further specification of either the social utility function or income distribution has to be given before an

[1] I am indebted to professors Ragnar Frisch and Tj. C. Koopmans for their help in finding my way through the highly specialized literature in this field.

[2] It may, however, be that other methods of transferring income between the subjects of an economy are so difficult to organize that the method of income taxes of the usual type has to be chosen, nevertheless.

optimum situation can at all be deduced. A well-known choice is the existing income distribution (after allowance for income transfers as they exist already) and the resulting system of free-trade world-market prices that would result. For small countries existing world market prices are sometimes taken as given. Either price system can be used to define a "total value of production". This total value of production (either at free-trade world-market prices or at existing world-market prices) will then be made a maximum by perfect competition, provided the other conditions are fulfilled on which the optimum proposition is based.

6. The most important of the other conditions may be summarized as follows: (i) at least one factor of production is fully used; (ii) exchange possibilities will not be threatened with interruption; (iii) marginal costs of production should not ever be decreasing; (iv) production techniques should not depend on the length of time during which they have already been applied; (v) productivity does not depend on the way income is distributed.

2.23 This optimum proposition of free exchange has exerted an enormous influence on economic policy, as we already stated. It has led the liberals to advocate non-intervention in matters of economic policy. Indeed, without going as far as advocating complete non-intervention, almost any political party would use it as an argument for leaving certain sectors of economic life, at least, to themselves. It may be said to be the basis even of a good deal of socialist ideas, especially as far as the freedom of consumption, the freedom to choose one's job and a claim for freedom of minor management decisions of socialized enterprises is concerned. The main problems of economic policy may indeed be formulated as consisting of *finding out the limitations* to this general theorem and deriving the necessary modifications to a policy of fundamental freedom of action. These limitations will prove to be important enough; but still a good deal of modern economic policy, including socialist policy, may well be said to have the task of (i) providing a certain framework of institutions within which very much can be left to the free action of producers and consumers and of (ii) correcting certain less desirable consequences of the system of free exchange.

2.24 A discussion of some important factors that invalidate the central proposition is therefore needed.

(i) The *full use of at least one factor of production* is not at all times guaranteed. In periods of depression unemployment may develop, even if there is no lack of capital or land. If such unemployment develops, wages do not quickly react and even if they react, demand for labour does not increase quickly and sufficiently. For these reasons the full use of at least one factor of production has to be a subject of deliberate concern of the policymaker (cf. §§ 3.5 and 4.1).

(ii) If *interruption of the process of exchange* is a possibility, as in the case of war, it may be wiser to deviate from free pricing and production and, in particular, from relying on imports for essential goods.

(iii) Free pricing appears to be *impossible* for goods produced under *decreasing marginal costs* for the complete range of production. It would lead to prices equal to marginal costs and these would be below average costs and hence imply permanent losses to their producers. This has in practical life led to the creation of monopolistic organizations which then do seem to be justified.

(iv) If techniques *depend on the time during which they have been applied*, that is, if the element of experience plays an important role, there may also be good reasons to deviate, if only temporarily, from free pricing and production (the "infant industry argument").

(v) Finally, it may be that *maximum production* value or "efficient production" does not represent the aim of economic policy, or not the only one, and so deviations from free pricing seem justified. In particular, questions concerning the distribution of the product over the members of the community may have this effect.

2.25 One of the further limitations to the relevance of the central proposition of free-enterprise economics is caused by the *static* character of the assumptions from which it is derived. No account is taken of the difficulties that may arise from the process of adaptation, for this necessarily requires a dynamic analysis. Among the features of the processes of adaptation, to be called dynamic features, there are several which lead to unstable processes. An unstable process is one which, instead of moving from the old equilibrium directly to the new one,

produces unnecessary swings or never even reaches the new equilibrium. This can be a consequence of the existence of "lags" in the reactions, or of the occurrence of speculative effects, or of the role played by stocks.[1] Sometimes, therefore, deviations from free pricing and trading will be justified and even necessary in order to avoid instabilities in the adaptation process.

2.26 Apart from the general theorem just discussed there are one or two minor conclusions of a theoretical nature, to be drawn from models, that deserve attention. The first refers to the implications of *durability*. For a durable good, especially if its life time is considerable, the annual flow of production is necessarily small in comparison with the total stock available. Changes in that annual flow, even if considerable as a percentage of that flow, cannot, within a short time, influence the market position of that good to any appreciable extent. It is well known that rents, for example, cannot react appreciably on, say, an excess in building activity, except after some years. This is a reason for rents being a poor regulator of the housing market. For similar reasons the influence of the rate of savings in one individual year on the rate of interest is only a very remote one and so, therefore, is its influence on the inducement to investment.

A second statement that can be derived from a consideration of orders of magnitude is that changes in the price of a commodity or service which is only a minor factor in the production of a certain product will not influence the supply of that product very much: those changes have little effect on the cost and hence on the profit margin. Thus it is well-known that price changes in a minor raw material of any product do not influence the supply of that product. Similarly, the influence of the short-term rate of interest on general activity is very restricted: Short-term credits are only a minor component in the process of production as a whole.

2.27 Conclusions from *statistical testing* can only be conditional in nature. Statistical tests never can prove a certain causal relation to be "true". It can only be stated that if certain variables, x, y, z..., may be assumed to be the most important ones to cause fluctuations

[1] For a more detailed treatment of such processes see W. J. Baumol, Economic Dynamics, New York 1951.

in another variable u, and if the additional influences may be assumed to be stochastic, the most probable size of the influence of x, y or z on u is so and so much. So it has been proved that if profits and equipment prices are the most important variables affecting fluctuations in investment activity, the influence of the rate of interest on investment activity in the past has been relatively weak. Put in another way this means that if profits etc. are an important factor, the changes, in the past, in investment activity have been mainly due to changes in profits and to a much smaller degree to changes in interest rates. It does not follow that, should profits be much more stable in the future than they have been in the past, the influence of the interest rate would not then be relatively larger.

Similar statements can be made about the price elasticity of demand for a large number of goods. If it is true that fluctuations in income are the most important causes of changes in demand, then the price elasticity of the demand for many goods appears to be fairly low. Substitution, in other words, is of some importance only between goods as closely related as various types of meat, or as margarine and butter; not between the, say, twenty items into which the complete set of consumer goods will usually be subdivided.

Finally, if prices of manufactured products are primarily dependent on costs, their flexibility appears to be rather high, that is, these prices are only influenced to a small extent by the quantity demanded. Only if this quantity comes close to the capacity for producing these goods, will its influence on prices become important, that is, in the "bottle-neck stage".

If incomes and prices are the most important factors making for demand in international trade, it appears that short-term elasticities of substitution are moderate. This comes to saying that a price decrease of country A's product, while country B's product does not change in price, will affect the demand for A's product in relation to B's only moderately. In many cases, a relative price reduction of 1% will only lead to a relative demand increase of some 2% and often no more than 0.5 or 1%. This is particularly true for nonstaples and for exports as a whole. For staples higher elasticities will be found. Long-term adaptations of total exports (i.e. after some 3 years or longer), will show elasticities up to about 4.

2.3 Survey of Models Used as Examples in this Book

2.31 In order to illustrate the use that may be made, in the design of economic policy, of economic models and in order to give a hard core to some of the propositions on economic policy that will be made in this book, some twenty models have been constructed or taken from literature and described in Appendix 3. These models are the basis of some thirty separate "problems" defined with some precision and spread through chapters 3 to 6 inclusive. Appendix 1 provides a survey of the models used and Appendix 2 a list of the "problems" treated with their aid. It has been thought useful to give a brief characteristic to each model—although for the reasons given previously such a characteristic cannot claim to be unambiguous. The choice of the models will be discussed in the remaining sections of this chapter. In the survey the number of variables involved, specified according to 35 categories, has also been indicated. The categories have been described in brief in the heading of the table of Appendix 1; certain further specifications can be found in Appendix 4, giving a list of variables used in the various models. Because of its completely different character, model 08 has not been summarized in Appendix 1 and the notation used has been explained separately. Some general remarks on the notation used for the other models will be given here.

2.32 *Latin* letters have been used to denote economic variables and some variables that are closely related to them but which sometimes play the role of instruments (wage rates, government expenditure). *Capital* letters indicate money sums (either flows or stocks); the other Latin characters therefore indicate either prices or quantities. *Greek* letters, which are not explained in Appendix 4, indicate data and more particularly coefficients in structural equations, that is multiplicative data usually representing elasticities, propensities, quotas and related concepts. These Greek letters usually are the same as the Latin letter representing the variable at the left-hand side of some structural equation. They are defined in the detailed description of models in Appendix 3. Greek symbols may be specified by lower indices if more of them occur in one equation. Lower indices with economic variables are used to indicate time periods and will therefore only be found in dynamic models. Top indices are used to indicate specifications of

variables; if a larger number of "compartments" (either industries or countries) is distinguished, they are specified by a top index h, of which the highest value is H. In model 15, transactions between sectors are indicated by two top indices, characterizing the sector of origin and the sector of destination.

2.33 In some of the more complicated models it appears to be useful to introduce, apart from the *absolute* value of any variable, its *deviation* from a certain initial or equilibrium value. This deviation plays the major role in the computations and has then been denoted by the simplest symbol used, the symbol without any bar; if this is the case, it is mentioned explicitly. The initial value is then represented by a barred symbol and the absolute value by a doubly barred one. The same method has been followed in a single case where a Greek symbol represented a variable (namely, in model 18, symbols α_1 and α_2). In all other cases the unbarred symbol represents the absolute value of the variable or constant considered.

2.4 Closed Static Models

2.41 The models listed under this heading refer, as is clear, to closed economies and therefore disregard foreign relations. For the world at large this is evidently permitted, whereas for a country like the United States it is a possible first approximation. They may also be used for a group of countries of sufficient total "size", if "size" is used to refer to the degree of isolation. These models have the advantage of showing certain fundamental tendencies in the internal problems of the economies concerned, without confusing the student by the complications of foreign trade. They have been used by almost all economists.

A first group (01–05) is in addition of the *macro* type, which further simplifies them. Clearly, they are only useful so long as all sectors in the economy show almost parallel changes, but this is, as a rule, characteristic of both the general cycle and the process of general development. The models to be described here are very well known in literature and their advantage lies in their simplicity. They will all be indicated by short names summarizing their main characteristics. A full description is given in Appendix 3.

2.42 MODEL 01: MONEY FLOW MODEL

The first to be discussed is the simplest Keynesian model, where only two variables are considered, national income and outlay. The model is essentially meant to represent the behaviour of the economy during short-term movements. The two relations represent, to put it briefly, the *income formation* and the *income spending equation*. The first says that, in a closed economy, income originates from total expenditure, from which no deductions have to be made, because no imports of raw materials take place. Expenditure as far as for investment goods should be taken net, however, i.e. gross investment expenditure minus depreciation allowances. To the extent that replacement exceeds depreciation it has to be included in gross investment. If replacement falls short of depreciation allowances, it contributes to gross investment by a negative amount.

The second equation, that of *spending* income, indicates the "laws" of spending, or the behaviour of income recipients with regard to spending. Keynes' simplest hypothesis is taken, in which it is assumed that expenditure depends only on income, i.e. consists of a constant "autonomous" portion X_0 and a portion varying with Y, but not necessarily proportionally.

2.43 MODEL 02: MONEY FLOW AND PRODUCT FLOW MODEL

The second model is derived from the simplest Keynesian model by the introduction of one further element. In the simplest model no distinction is made between the money flows of income and expenditure and their "real" counterpart, the quantities of goods they represent. It depends on the level of *prices*, whether the same flow of money commands a larger or a smaller quantity of goods. A third variable therefore intervenes, the price level. A third equation has now also to be added, expressing the action of those who fix prices. Usually the price level, in short-term cyclic movements especially, is itself dependent on the "economic position", i.e. on the level of demand, since, apart from autonomous elements such as cost changes, a higher price can be charged the stronger is the market position. Simultaneously, the higher the demand, the more need is there for the supply of marginal suppliers, which can only be attracted by a higher price. This is what equation (3) expresses. Equation (4) is a definition.

2.44 MODEL 03: MONEY, PRODUCT AND FACTOR FLOW MODEL

One further element is now being introduced, namely the most important factor of production (as far as short-term fluctuations in activity are concerned), *labour*. Not only will the money flow of demand and the price level (and therefore the product flow) vary in the course of short-term fluctuations, but also the flow of factor demand, in this case employment. This has various implications. It becomes possible for the composition of income to change with changes in its size. And, since expenditure may be dependent on income composition, it becomes necessary to specify income. Labour income will depend on employment, but also on the wage rate l, which therefore has to be added to the list of variables. Unless we consider it as an autonomous datum (which is justified in the case where the wage rate is considered to be an instrument of economic policy), we have to add an equation expressing the behaviour of wage-fixers. We will, however, consider l as an instrument of policy (except in § 6.4).

Finally employment a has also to be determined and will, as a first approximation, depend on the volume of production x. It need not be proportional to x and hence it has been assumed in equation (4) that the relation is again linear with an autonomous term.

2.45 MODEL 04: MONEY FLOW AND PUBLIC FINANCE MODEL

This is another generalization of model 01, where the role of government is somewhat more specified in that a distinction is made between *government expenditure* and other expenditure by the economy (private expenditure), while *taxes* are introduced at the same time. Government expenditure is considered to be an autonomous variable, namely an instrument of economic policy, whereas taxes are assumed to consist of both an autonomous part and a term depending on income.

2.46 MODEL 05: MONEY FLOW, PUBLIC FINANCE AND ASSETS MODEL

This again is a generalization of model 04, in that the "public" is now supposed to hold *assets*. Two types of assets are introduced, namely *money* and *bonds*, of which the quantities held are M and B, respectively. It is assumed that the issue of bonds is an instrument of economic policy and that therefore B represents a datum. The amount of money

in the hands of the public at the end of each time period will then depend on their incomes, their expenditure and the value of the bonds ΔB added to their assets; the nature of equation (3), expressing this, being that of a "balance equation" or a "finance equation".

2.47 The second group of "closed static models" will be a pair of *micro* models, though still of a very simple nature.

MODEL 06: HORIZONTAL MONEY AND PRODUCT FLOW MODEL

This is a generalization of model 02 in that it assumes the existence of a large number of different final goods that may be bought, the prices and quantities of which need not necessarily move in a parallel way.

2.48 MODEL 07: HORIZONTAL MONEY AND PRODUCT FLOW MODEL WITH MONOPOLIES

This model differs from the preceding only in that it is assumed that one or more of the products are monopolized and their prices accordingly fixed so as to maximize profits under certain conditions to be specified.

2.49 MODEL 08: MODEL FOR INCOME DISTRIBUTION

This model is of a completely different nature. Instead of making a distinction between different products it lumps them together as in the macro models, but here productive services are considered in detail. A large number (in fact an infinite number) of different jobs is introduced and the income formation process is presented as a price formation process with supply and demand as instruments of analysis. Each job is described by the intensities of the required abilities and each individual by the actual intensities of these abilities he shows. The choice made by each individual is assumed to be based on a utility function. It is further assumed that the income scale for the various jobs depends on the required intensities as well as on the quantity of product delivered and the scale is supposed to be fixed in such a way as to equate demand for and supply of jobs in each category.

2.5 Closed Dynamic Models

2.51 Dynamic models have an important part to play in the expla-

nation of economic movements. They are less important, however, in policy designing. Decisions have, as a rule, to be taken with respect to relatively short intervals; and most of the problems will refer to what is to happen in the next short interval. The development up to the moment of decision can be considered as known and given. The unknowns (as a rule the values of the instruments) then refer to one, the next, time interval, and the nature of the problem is then a static one. This explains why dynamic models are often not needed even if problems of rapid change are being considered. Nevertheless there are problems of policy for which such models will be needed, namely problems in which a longer series of events has to be considered.

2.52 MODEL 09: DEVELOPMENT MODEL

A first example is supplied by the problems of development. Model 09 is a very simple model on the interdependency between *capital formation* and future production. It is a model in physical concepts only, considers a succession of time units, in which savings are accumulated and used to build up a growing stock of equipment, leading to a rise in production assumed, for simplicity's sake, to be proportional to the stock of equipment. A distinction is made between depreciation and replacement and between the stock of equipment (or capacity) and the stock of capital.

2.53 MODEL 10: BUSINESS CYCLE MODEL

The number of models of the business cycle that has so far been presented is embarrassingly large. Most of them contain a large number of variables, probably in agreement with reality. It would lead us much too far to try to introduce such complicated models here; our intention being to illustrate rather than to present complete schemes. This is why a very simple model bearing on certain features, only, of real cycles has been chosen in this series; features which appear to be interesting from the political point of view.[1] These features are, the cumulative process during upturn and downturn

[1] Readers interested in more realistic and refined models of the cycle may be referred to L. R. Klein and A. S. Goldberger, An Econometric Model of the United States, 1929–1952, Amsterdam, 1955 and J. Tinbergen, Business Cycles in the U.S., 1919–1932, Geneva, 1939.

(connected with lags between income and expenditure), the existence of an upper and a lower value of total expenditure and the influence of price movements (as distinct from price levels) on income calculations and hence expenditure. In the author's opinion, this latter feature, the phenomenon of "*paper profits*" has, wrongly, been somewhat neglected in many models of the cycle. It may be somewhat overemphasized in the present model.

2.6. Open, Static Macro-Models

2.61 After having dealt with a number of problems in countries (or combinations of countries) for which *foreign trade* can be neglected, we will also have to study policy problems in countries on which international trade has an important impact. In order to make comparisons easy, the models for this group of problems have been chosen in all other respects similar to models 01 to 05 inclusive and been numbered 11 to 15. There is one exception however: the separate variables of public finance, namely tax revenue and public expenditure, have not been introduced. Instead the rate of exchange has, in model 15, been introduced as a variable.

2.62 There is of course no clear-cut boundary line between macro and micro models. A micro model is one in which a number of different sectors of the economy are separately introduced: what number is a question of taste. We have chosen to call micro models some (to be treated in § 2.7) which others might have considered still as macro models. A model is included in which some details of public finance have been introduced.

2.63 In agreement with what has just been said, the characteristics of the models in the present section are the following:

MODEL 11: OPEN MONEY FLOW MODEL

This is the simplest Keynesian model which contains only money flows, but now including imports and exports. This is the model used for the "*foreign trade multiplier*" by Machlup and others. The money value of imports is assumed to depend in a very simple way on nominal national income, which evidently constitutes a heavy simplification.

2.64 MODEL 12: OPEN MONEY AND PRODUCT FLOW MODEL

Here again, a distinction between money flows and product flows is introduced, implying that prices also enter into the picture, prices being important in international competition and therefore even more essential in open than in closed economies. Here it is possible to make more precise assumptions as to the relation between imports and the internal economic situation. It has been assumed that the volume of imports is directly related to the volume of gross product.

2.65 MODEL 13: OPEN MONEY, PRODUCT AND FACTOR FLOW MODEL

In addition to the flow of products the flow of labour is now considered separately, and consequently its price, the wage rate, becomes an important potential instrument of economic policy. Because of the simplifying assumption that labour income is spent in the same way as non-labour income, and labour productivity is not supposed to change, it is not necessary, however, to introduce employment as a separate variable. This will be done in models 16, 18 and 19.

2.66 MODEL 14: OPEN MONEY, PRODUCT AND FACTOR FLOW AND EXCHANGE RATE MODEL

For open countries the target of balance of payments equilibrium may be added to the two discussed for closed economies, namely full employment and monetary equilibrium; and accordingly a third instrument of policy will also be needed (cf. § 4.1). This is why an open model with both wage rates and exchange rates is here presented.

2.67 MODEL 15: OPEN MONEY FLOW AND ASSET MODEL

The introduction of financial assets is also of particular importance to open economies since their exchange may influence the balance of payments. This has been done in model 15, where the principle of the monetary survey as conceived by Schouten has been introduced.[1]

2.7. Open, Static Micro Models

2.71 As already stated we have chosen the term micro to apply even

[1] J. Tinbergen und D. B. J. Schouten, "Die Anwendung des Nationalbudgets zur Beurteilung der Währungslage," Wirtschaftsdienst 34 (1954) p. 4.

to a model where, apart from a "macro" treatment of the business sector, public finance is described in some more detail, bringing the number of variables already to 13; we also apply it to models where some sector of the economy is treated in detail, a model which we may call a "focussing model". Like a looking glass it shows us part of the object in detail and sharply, whereas the rest is more vaguely described in outline. Accordingly the following models are being considered here.

2.72 MODEL 16: OPEN MONEY, PRODUCT AND FACTOR FLOW AND PUBLIC FINANCE MODEL

This model is a combination of more features than have so far been combined and will serve as a basis for a "multi-purpose policy" as it usually occurs in practice. It makes a distinction between consumption and investment, between factor-cost and the market-price value of consumption, introduces direct and indirect taxes, and a different spending pattern for workers and independents. It still does this in the very simplest way possible and might be made far more complicated if less simple assumptions concerning the same phenomena were made.

2.73 MODEL 17: OPEN MONEY FLOW, ASSETS AND BANKING MODEL

This is a focussing model for certain questions of banking policy. A complete, but still simplified, balance sheet for the banking system is introduced, in addition to what has to be the basis of every model, the main money flows of the economy.

2.74 MODEL 18: OPEN, TWO-INDUSTRIES PRODUCTIVITY MODEL

This model focusses on two industries, of different structure, and on the results that may be due to changes in productivity in an open country. In contrast to the previous models, it therefore varies the ratio between the volume of production and the volume of labour employed, and this independently in the two industries.

2.75 MODEL 19: OPEN HORIZONTAL MONEY, PRODUCT AND FACTOR FLOW MODEL

This model is comparable to model 06, but applies to an open economy. It has, in addition, been made somewhat more general in that now

expenditure on each commodity is assumed to depend on all prices. This is a type of complication which brings this model very near to Leontief models in which inter-industry physical flows are considered.

2.8. Open Dynamic Micro Model

MODEL 20: PRIORITY CRITERIA MODEL

Only one example will be treated in this category, namely a model to be used for the discussion of *priorities* among a group of investment projects. In order to give a complete discussion it is necessary not only to distinguish between the projects, which makes the model clearly a micro model, but also between present and future time units, which makes it a dynamic one.

2.9. Groups of Economies Model

In many respects there is no difference between industries and countries as compartments of an economy. It is therefore for the economist rather than for the mathematician that a separate type of models is announced under his heading.

MODEL 21: GROUP-OF-ECONOMIES MONEY-FLOW, PRICE-LEVEL MODEL

In this model, with full employment and balance of payments equilibrium as targets and public expenditure and price levels as instruments, the most important short-run international policy, as dealt with by Meade in particular is discussed.