CHAPTER NINE

ECONOMIC STATICS AND ECONOMIC DYNAMICS

DATA AND VARIABLES

IN CHAPTERS II–VIII we have given a description of the fluctuations of economic variables. Our second task, to which Part II is devoted, will be to give an explanation of these fluctuations. We enter therefore into the field of economic science. Before we devote our attention to the concrete problems presented by the observation of economic fluctuations, we must, in this introductory chapter, make some general remarks concerning economic science itself.

The subject matter of economic science is the process of satisfaction of human needs. This process takes place within the framework of natural, technical, and institutional conditions that may be considered as given. Among them we may count the size and composition of the human population, the psychic characteristics of the people, the natural resources of the countries in which they live, the technical means they use, the legal structure—free competition or a more controlled economy—etc. From these data follow certain phenomena and magnitudes, with respect to the satisfaction of needs, which we call "economic phenomena" or "economic magnitudes." Examples are the quantities of various commodities and services produced and traded, prices, incomes, and expenditures of individuals. The magnitudes of these variables are the unknowns in the quantitative problem that economic science has to solve.

It will be noted that the definition of the purpose of economic science has been stated rather loosely and, in particular, that the division between those magnitudes which are given and those which must be considered as unknown has been indicated

by examples only. This looseness of definition, which may be thought unsatisfactory by some, is due to the fact that within the entire field of economics a great variety of problems is conceivable and admissible, and the border line between given magnitudes and magnitudes to be determined varies according to the problem under consideration. Certain economic problems may be posed in such a general fashion that even parts of the legal structure of the country may be considered as unknown. On the other hand, it will often be suitable even for problems of a very high degree of abstraction to assume as given the stock of capital goods available to a certain population; in still more general problems, however, this variable will no doubt have to be considered as an unknown. In the more limited problems, with which economics has been most productive, it will often be possible to assume as given all magnitudes outside one particular market.

In each economic problem there are, therefore, certain given variables which may also be called "data," or "exogenous variables." Those data, which must be considered as given even in the most general economic problems, will be called the "fundamental economic data." Among such data we may distinguish between those that are constant and those that are variable. The size of the population, the stock of capital goods, the main outlines of the legal organization and of technical knowledge, are normally assumed to be constant or nearly constant; on the other hand, annual crops and certain parts of the legal organization, tariffs for example, are considered as variable data. The more constant data describe the characteristics of the economy under consideration or of a certain portion of it; these data are often referred to by the term "economic structure."[1]

The results of economic science are often put in the following form. From the given values of the economic data, certain

1. It follows from this definition of economic structure that one cannot count as part of the structure the ratio between agricultural and industrial production and similar magnitudes which are often considered as elements of the economic structure. The volume of production is an economic magnitude, not a datum. We prefer, therefore, not to consider this ratio as an element in the economic structure but to reserve this term for the more fundamental magnitudes of natural and technical character that lie behind this ratio, such as the quality of the arable land, the size of the population, and per-

values follow for the economic variables; for instance, with respect to an individual market: Given productive capacity and costs as data on the supply side and incomes and preference scales of potential buyers as data on the demand side, the quantity sold and the price are determined (leaving aside many details, for purposes of simplification). Another example for an economy of a very simplified structure would be the following: Given the size of the population, the stock of capital goods, the preference scales of the individual persons, and the production function (that is to say, the technical coefficients), the volume of production, the real wage, and the real rate of interest may be determined.

The values for the economic variables determined in this way are thought to "correspond to" the given values of the data; in accordance with the type of reasoning given, they are equilibrium values. In other words, the theory implies the additional assumption that the situation is stationary; and the question is put this way: How large should the volume of production be, how high should the price level be, in order that the situation remain stationary? The question as to what would happen if the situation were not stationary falls outside the scope of this line of reasoning. When the data change, the preceding values of the economic magnitudes cannot be maintained. A process of movement will occur. But the type of theory to which we refer does not describe this process. It describes only a position which would continue to exist once it has come into existence. The theory does not concern itself with the question whether this situation will actually come into existence. This would require that (*a*) the data remain unchanged after an initial change and (*b*) the movement of the economic system is in the direction of adaptation, or, in the terminology introduced earlier, represents a damped process. If the process following upon a change of data were of a different character, particularly if it were undamped or antidamped, the new equilibrium position would

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haps the stock of capital goods. To the extent that these more fundamental magnitudes determine approximately the ratio indicated—with little effect of other economic variables—it may be said that the ratio reflects approximately an element of the economic structure.

never be reached. Nor would it be reached if the data were changed again before a damped process had led to the attainment of the new equilibrium values.

STATICS AND DYNAMICS

The economic theory which is based on the assumption of a stationary position may be called "economic statics." It may be said that this theory is applicable only to long-run tendencies, provided always that the movements set into motion by the changes in data are damped and that the data themselves do not change again in the meantime. It would also be applicable if these movements were damped and took place very rapidly, in other words, if the economic magnitudes adapted themselves immediately to the data. This latter assumption is often made tacitly, sometimes with more justification, sometimes with less.

If this assumption is satisfied, movements in the economic variables can occur only as a consequence of movements in the data. Many attempts have been made to explain economic movements on this basis. This approach, in which situations corresponding to different values for the data are compared, has been called "comparative statics." We have seen, however, that there are not only immediate but also gradual processes of adaptation. In the latter, movements occur even though the data remain unchanged. It might be argued that such movements require at least a change in the data to be set into motion. But this is not necessarily the case. The process of change that consists in the accumulation of capital and that follows from the tendency to save and the tendency toward expansion of production need not be set into motion by any change in the data.

Movements that occur while the data remain constant are called "endogenous movements." As we shall discuss in more detail below, we consider cyclical movements as endogenous movements to a considerable extent. We mentioned, further, the process of accumulation. Movements that may be considered as the immediate, or the almost immediate, adaptation to changes in data are called "exogenous movements." An impor-

tant part of the seasonal movements may be considered as such. The development of an economy in consequence of an increase in the population may also be considered as an exogenous movement. Here, the adaptation is not immediate in the limited sense of the word; it may take a year, for instance, before an increased supply of labor may lead to a corresponding reduction in the wage level. But compared to the periods over which relevant changes in population occur, a year is a relatively short span of time, and the adaptation may be considered as nearly immediate. It is assumed in this example that the movement of the wage rate is in fact an adaptation and not an undamped, or antidamped, process; there are good reasons for this assumption.

It will be clear from the preceding remarks that conventional economic statics cannot contribute to the explanation of endogenous processes. The theory which is necessary to explain these processes and which will follow step by step the process of adaptation and the succeeding movements will be called "economic dynamics." Economic dynamics has also been defined quite accurately as the economic theory of the relations between variables at different moments of time (Frisch). Yet dynamics is not so totally different from statics as is sometimes believed. It is based on much that has long been accepted by economic research workers but that, in statics, could be used only in part. An important difference between statics and dynamics is that the latter can never be indifferent to the question as to how much time a certain change takes. Economic dynamics must measure time also; it must incorporate time in its analysis as one of the variables.

As a consequence, economic dynamics is nearer to reality and, by being less abstract, is sometimes simpler. Economic statics may put forward the theorem that a certain commodity will not be produced in the long run if the production involves a loss. In the short run, however, production at a loss will occur. Economic dynamics will take this fact into consideration and will on that account be more realistic.

Let us analyze a slightly more complicated example to illustrate this point further. Economic statics shows us that a techni-

cal improvement which reduces the cost of production of a certain commodity will lead to a new equilibrium with a lower price and a larger quantity sold. Economic dynamics will describe the process in terms of the successive reactions of the economic subjects participating. Following a reduction in cost by, say, five cents, the suppliers may reduce the price by, e.g., three cents, with a view to selling so much more at this price as to maximize their profit. This implies a certain expectation concerning the quantity salable at the lower price, an expectation for which no empirical basis may be available. The price reduction will lead to a certain increase in the quantity sold. If, however, the increase in the quantity sold is greater than had been expected, it may be more profitable for the suppliers to raise the price again somewhat, depending on their cost curve. Let us assume that it is to their advantage to raise the price and that they raise it by one cent. This will again lead to a small reduction of the quantity sold. In this way the well-known process of trial and error will be executed. Static economic theory may make some reference to this process, but it makes no use of it; it does not study the process. Analysis by economic dynamics will lead to the conclusion that the process of trial and error will not necessarily lead to an equilibrium position. The well-known cobweb theorem—one of the theorems of dynamics—shows this in detail.[2] In this respect, economic dynamics is more realistic than economic statics. By its separation of the process of trial and error into a number of successive reactions, indicating at each stage clearly what is cause and what is effect, economic dynamics gives a picture which is much more readily understandable than that of economic statics.

SUPPLY AND DEMAND ANALYSIS

A very important instrument in both static and dynamic economics are the supply and demand schedules used to describe a market. We must devote some further attention to this subject. Various alternatives are possible; we shall deal here with the most usual one based on free competition. In a market, a sale of a certain commodity takes place. The sale reflects an

2. Cf. p. 235, *infra*.

agreement between sellers and buyers. The quantity sold is at the same time the quantity that the buyers are prepared to buy and the quantity that the sellers are prepared to sell. If we call the first quantity the quantity demanded and the second quantity the quantity supplied, then there must be equality between the quantity demanded and the quantity supplied. Both depend on a number of other variables. One of these is the price of the commodity in question. But the quantity demanded depends not only on the price but also on other variables which we may call "demand factors." For consumers' goods these demand factors may be, for instance, the income of the buyers and the prices of other commodities. In the case of producers' goods a number of other, technical factors may also be of importance. The quantity supplied depends not only on the price but also on a number of other variables which we shall call "supply factors." For most commodities the cost of production and the size of the productive capacity should be considered as supply factors.

Given the supply and demand factors, the quantity demanded and the quantity supplied will be determined by the price only. For every given price there will be a certain value of these two quantities. A relation of this nature may be expressed in a table, either a demand table or a supply table. The relations may be referred to as demand functions and supply functions; the quantity demanded and the quantity supplied are both "a function of the price." These functions or tables may be expressed in a diagram (see Fig. 40). In a rectangular system of co-ordinates XOY every point is characterized by two numbers, the X-co-ordinate and the Y-co-ordinate. According to the demand table, a certain value Y of the quantity demanded will correspond to a given value X of the price. These corresponding values can be represented by one point in the diagram. If the price is changed, another point is obtained. All these points together form a curve, the demand curve. A supply curve can be constructed in the same way. Both the demand curve and the supply curve correspond to given values for the demand factors and the supply factors.

In the market under consideration transactions will occur

only at that price at which the quantity supplied and the quantity demanded are equal. This price may readily be determined if the demand curve and the supply curve are known and are drawn in the same diagram. It is the price which corresponds to the point of intersection of the two curves (Y^s). At that price, the quantity supplied and the quantity demanded are equal, and X^s is the quantity sold and bought. The price and the quantity sold follow from the demand and supply functions, that is to say, from (a) the values of the demand and supply factors and (b) the coefficients reflected in the demand and supply functions. One might also say that they follow from the position and

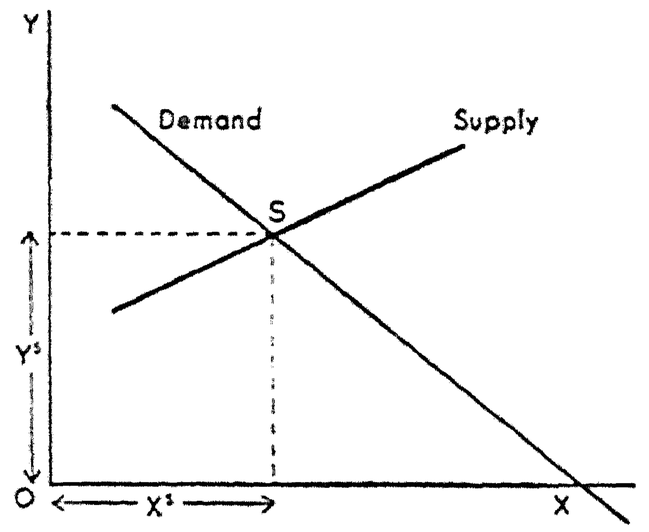

FIG. 40.—Demand and supply curves and their equilibrium point S

the slope of the demand and supply curves. In the simplest case—which is often a good approximation to reality—where the two curves are straight lines, each of them is determined by two numbers. For these two numbers one can select different pairs. One may take, for instance, the intercepts with the two axes. Or one may take the intercept with the Y-axis and the slope of the curve or the intercept with the X-axis and the slope of the curve. We select here the last-mentioned pair of numbers. The intercept with the X-axis represents the quantity demanded or supplied at a zero price. It may be rather difficult to see the economic sense of this particular number. One could take just as well the quantity demanded or supplied at any other fixed price. Graphically, however, the first concept is simpler because it does not require an additional vertical line in the diagram. It is also simpler algebraically; but, in line with the

scope of this book, we shall not pursue this point. We shall call the intercept with the X-axis the "level" of the supply curve, or, respectively, of the demand curve. We state, therefore, that each of these two curves is determined by its level and its slope.

The level and the slope of the demand curve depend, among other things, on the values of the demand factors. They depend, further, on given data of a more fundamental character, such as the preference scales of the buyers. For other demand factors and other values of these data the level and slope of the demand curve will be diffierent. No general statement can be made as to which way the slope will be affected. On the other hand, it is

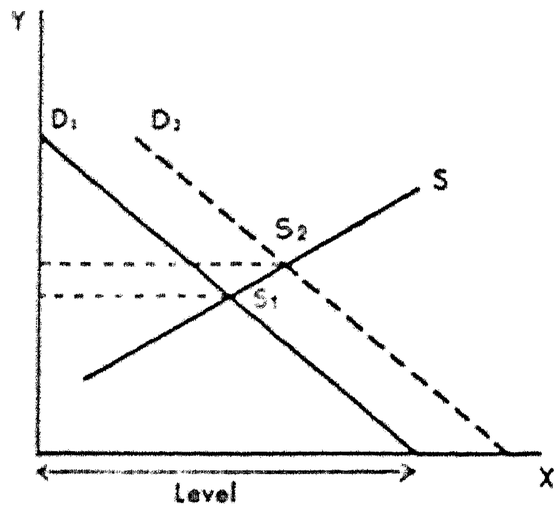

FIG. 41.—Change in level of the demand curve and its effect on the equilibrium point.

usually possible to state in which direction the level of the demand curve will move if income is increased or if the price of competing commodities is increased. In view of this, changes of the demand factors may as a first approximation be considered to affect only the level of the demand curve and not its slope. An increase in the income of the buyers will lead to a higher level of the demand curve and so will an increase in the price of a competing commodity; an increase in the price of a complementary commodity will lower the level of the demand curve. In all these cases we may assume a parallel shift of the demand curve. This shift, due to a change in demand factors, will lead to a shift in the point of intersection of the demand and the supply curves (see Fig. 41). Similar considerations apply to the supply factors. An increase in productive capacity will lead to a higher level of the supply curve and so will a decrease in costs.

As we have stated, the slopes of the demand and supply curves (which are closely related to the elasticities of demand and supply) may, as a first approximation, be considered as remaining unchanged when the demand and supply factors change. The slopes will change, however, when some of the more fundamental data change, such as the preference scales of the buyers or the production functions of the sellers.

Sometimes, when changes in some of the more fundamental economic data (not those of one market but of the entire economy) are the object of study, the analysis has to be focused also on changes in the slopes of the curves; this, however, raises much more difficult problems. A change in the slope by itself does not yet determine the new position of the curve; the slope may be changed by rotation around any one point of the curve, and it makes much difference which point is selected.

We have described in some detail the mechanism of demand and supply curves because this mechanism is used as an instrument of analysis in both static and dynamic economics. In the light of what was said earlier, this may also be understood in the sense that the demand and supply analysis can be used in the explanation both of exogenous and of endogenous movements. In the static type of analysis it is assumed, as we have said, that the values of the economic variables adapt themselves immediately to changes in the data—in this particular case the data of one market. Changes in prices and quantities are then explained by reference to changes in the level of the demand and supply curves.

In dynamic economics, on the other hand, other explanations of changes in prices and quantities are possible. One of the simplest cases of this is that in which there is a time lag between a change in the price and the consequent change in the quantity supplied. The instrument of the supply curve is then used in a different way: to indicate not in what way the quantity supplied will be determined by the price in the long run or after complete adaptation but how it depends on the price which prevailed at a certain specific earlier period. If one knows that the quantity is determined by the price with a certain lag, the supply curve indicating such a short-run reaction may be quite different from the supply curve indicating the ultimate adjustment.

It may very well be, for instance, that the seller will change the quantity supplied in response to a change in the market price in the direction of the ultimate change but not to the full extent. Different psychological and technical conditions will determine how large this initial and provisional adjustment will be. In a quantitative application of the supply curve to the short-run reaction, one will have to use figures different from those which apply to the reaction according to economic statics. Any knowledge concerning the quantities involved can be obtained only by statistical measurement of the curves. To the extent that we have any statistical knowledge of these curves, we know the provisional rather than the final reactions. In the explanation of reality the final reactions are of importance only to the extent that a sufficient time elapses before a new change in the relevant data occurs. In a qualitative sense it is possible in any case to operate with the same concepts of supply and demand curves in dynamics as in statics; it is possible that the quantitative differences are not too great either.

The same situation may also be described in other words. If we assume that the quantity supplied depends not on the price at the time of supply to the market but on an earlier price, one may say also that supply is completely inelastic but that there is an additional supply factor, namely, the price at an earlier period of time. Logically, this proposition is unexceptionable; in further analysis it is, however, often more convenient to extend the concept of the supply function in the way we did.

An important intermediate case is that in which the supply function depends both on the current price, as in economic statics, and on the price some time before, as in our dynamic case. In such a situation the preceding price must be counted as one of the supply factors.

The instrument of demand and supply curves may be generalized into a dynamic instrument in many other ways. One of these consists in assuming that the quantity demanded depends not only on the price, either current or past, but also on the change of the price compared to a preceding period. The change in price may often play a role, particularly in demand functions when speculative purchases are of importance.

In the preceding examples, dealing with situations in mark-

ets that represented only a very small part of the total economy, it was assumed that the demand and supply factors were independent of the result of the exchange, that is to say, independent of the price and the quantity in the market under consideration. In other words, the demand and supply factors were considered fully exogenous in the particular market. Strictly speaking, this can never be exactly true, since incomes must always be dependent on the price and the quantity sold in every market. When the market is small compared to the total economy, this point may be disregarded. This approximation, however, is not permissible in connection with a market that represents a large part of the economy, for instance, the labor market or the market for consumers' goods in general. In the analysis of such a market more complicated systems are required, particularly in economic statics. In economic dynamics, on the other hand, we have the advantage (indicating once more how economic dynamics is in some respects simpler than economic statics) that a more complicated system is often not required; this may in particular be the case if certain lags may be assumed between the formation of income and the exercise of demand in the market under consideration. The quantity sold in a market will determine current income but not income at a slightly preceding period; in that case, the preceding income may still be considered as exogenous with respect to the market under consideration.

In both statics and dynamics it will be necessary to deal with a large number of economic variables in order to explain developments in the economy as a whole. If we are to handle a large number of markets and all the relations applicable to them, the number of variables involved will usually be very large. Since our minds are not able to operate at one time with a system of so many relations between a great number of variables, the general scheme will often have to be simplified in many respects. A number of examples of this will be given below.

In addition to demand and supply relations, a number of other relations, equally well known from conventional theory, will have to be used. We may mention, for instance, technical

relations, such as those which indicate the relation between the quantities produced of a certain commodity and the quantities of the factors of production employed in the production of that commodity. Further, we may mention certain definitional equations, such as the one stating that saving equals income minus consumption expenditure. We do not need to discuss these various types of relations at this stage since they present no particular problems.

The demand and supply functions as discussed in the preceding paragraphs indicate only one type of reaction, namely, the reaction of the quantity supplied or demanded to the price, the latter being considered as given. This is the normal reaction in certain markets, such as the security markets and the markets of the world's main staples. But this description of markets, in accordance with the classical theory of free competition, is not so suitable with respect to other markets. It is often more realistic to assume that the seller sets the price in response to the quantity sold, whereas the buyer determines the quantity he wants to buy in response to the given price. The buyer reacts in accordance with the classical scheme, but the seller does not. Both have specific reactions to either preceding or current economic variables, and these reactions can be described in a way similar to our description of supply and demand functions, even if they refer to variables other than quantities and prices. Much of what we discussed before, therefore, has very general validity and may also be used in the treatment of other problems of economic fluctuations.