

Chapter I: Conceptual Apparatus

The object of this monograph is two-fold: 1) to state and explain the controversy among economists over income theory; and 2) to use this controversy to illustrate the relevance of theoretical formulations to a) policy issues, and b) the testing of economic theories by means of consistency between observations and the "predictions" of the theory. In order to do this it is necessary to present an apparatus which states the issues of general scientific methodology as it is applied in economics.

In general, the characteristic of the scientific method is its emphasis upon the need for something more than formal internal consistency as the test of the validity of an argument: this something more centers around the consistency of an argument with a body of information about the nature of the world. A theory in any science must be translatable into an assertion that after a given set of operations upon the material of the world is performed, a specified set of observations will result. Therefore, a scientific statement is usually of the type, if a occurs, then b will follow.

Fruitful scientific hypotheses are not made in a vacuum. They are based upon a body of observations whose pattern exhibits some regularity; a scientist attempts to construct a theory so that it is consistent with this given regularity. It is true that corresponding to a given set of facts, there are an infinite number of conceivable hypotheses or theories. From this set of hypotheses only a few are ever stated. The hypotheses that are actually stated are the product of the insight and experience of the investigator. In no sense does this imply that the stated hypotheses are

the best; in fact the history of science consists of a process of forming, testing, rejecting, rewriting, and inventing hypotheses.

A necessary attribute of a hypothesis in order that it be considered "scientific" is its testability. Those theories which are not testable are not admitted into the body of scientific hypotheses which the investigator seeks to refute. For example, an excellent theory which will explain any of the world's phenomena is the simple statement "Zeus did it". Why has the price of eggs risen? Because Zeus inflamed the minds of egg dealers to seek higher prices from the poor. This is a splendid theory. It explains everything. Therefore it is completely useless. There is no body of observations, no set of facts which could ever refute the hypothesis, "Zues did it". In order for a statement to be admitted into the class of testable hypotheses there must be a body of observations which could conceivably refute it.

We shall call the verification or confirmation of a theory any set of pertinent observations which do not refute it. It is clear that the scientific method consists of rejecting those theories which have been refuted. The remaining theories are believed in, and used to control the environment. For example, we may have a theory which states that if income taxes are raised, consumers expenditures will fall; if we can control taxes, we can then change the level of consumer expenditures.

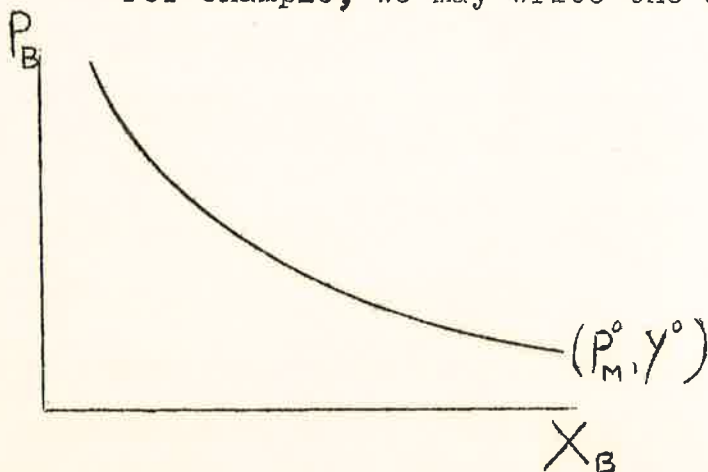
Let us assume that we have a number of theories consistent with the observations of the same phenomena: all are internally consistent, none contradicts any other theory in which it is rational to believe. Is it possible to prefer rationally one theory to another, or must a scientist keep all of the theories in mind? There is a convention which is often used: If two theories are equivalent in

all testable respects, but one has fewer preconditions, the one with fewer preconditions is preferred. On the other hand, if two theories are equivalent in all testable respects, but one connects more phenomena, the theory that connects more phenomena is preferred.

In order to control our economic environment we need confirmed theories about economic life. To have confirmed theories we need testable theories. To develop testable theories we need to specify the set of relations we are dealing with. Therefore, the first step in theorizing is a classification of the elements of economic life.

The essential technique to obtain a theoretical formulation involves the notion of "parametization". The idea is derived quite simply from elementary mathematics: a straight line, for example, can be written as  $y = a_0 + a_1X$ ;  $y$  is the dependent variable,  $x$  the independent variable,  $a_0$  and  $a_1$  are parameters. Given the form of the equation, every pair of different  $a_0$ 's and  $a_1$ 's determine a different line. If we fix  $a_0$  and allow  $a_1$  to vary, we get the entire family of lines that have  $y = a_0$  when  $X = 0$ , each line having a different slope. If we fix  $a_1$  and allow  $a_0$  to vary we get the entire family of lines that have the same slopes (parallel lines) but different  $y$  intercept ( $y = a_0$  when  $X = 0$ ).

For example, we may write the demand function of a community



for butter as  $X_B = f(P_B, P_M, Y)$

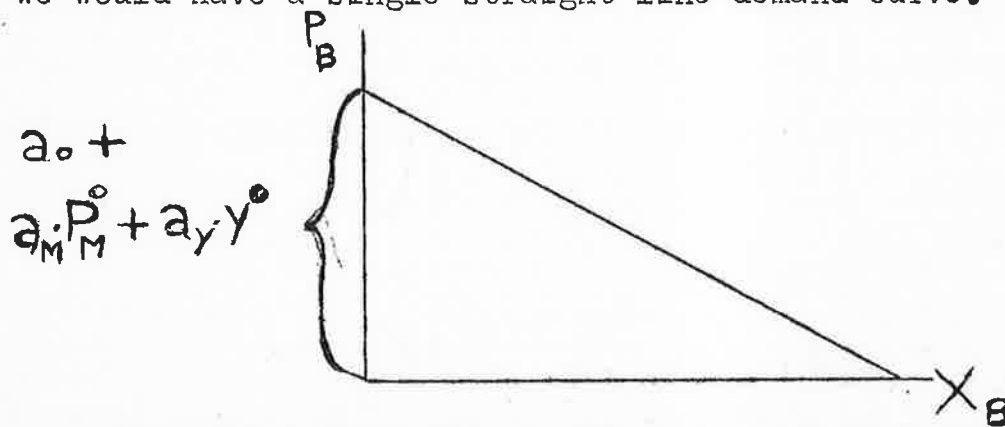
where  $X_B =$  quantity of butter demanded

$P_B =$  price of butter

$P_M =$  price of margarine

$Y =$  community income

We may specify that the relation between the quantity of butter demanded and the other variables is linear, so we can write  $X_B = a_0 + a_B P_B + a_M P_M + a_Y Y$  as the demand function. In this specification of the relation between the variables it is necessary to use four parameters ( $a_0$ ,  $a_B$ ,  $a_M$  and  $a_Y$ ). If we know the values of those parameters, then for each income level and margarine price we would have a single straight line demand curve.



In writing  $X_B = f(p_B, p_M, Y)$  we are not including many elements that may be pertinent to the determination of the quantity of butter taken, for example the price of lard, the distribution of income, the age composition of the population, perhaps even their religious beliefs. However, these do enter into the relation indirectly, as the elements which determine the values of the parameters; even though we may not be able to predict how the quantity of butter taken will be affected when these unspecified elements change.

The statement  $X_B = a_0 + p_B + a_M P_M + a_Y P_Y$  is a scientific hypothesis. If by means of empirical research we derive estimates of the values of  $a_0$ ,  $a_B$ ,  $a_M$  and  $a_Y$ , we can then say that there will be a specified linear relation between the quantity of butter taken and the price of butter, for each income and price of margarine. If the theory is to be consistent with observations, we must be

dealing with a world in which the values of the parameters derived from one experiment or one set of observations will apply to other experiments and other sets of observations. But the values of the parameters depend upon certain unspecified though relevant variables. For the prediction from our theory to be consistent with observations it is necessary that a) either these other unspecified (parametized) variables do not change, or b) if they do change they change so slightly that the variation in the predicted values which results is insufficient to make the prediction invalid. (That is, a theory which may be sufficient to yield a prediction within a given allowance for variation would have to be discarded if a more precise prediction is set as the standard for acceptance.)

On the basis of the observed regularity in economic life, the economist constructs his theories by beginning with a set of economic variables that he seeks to relate. All the other elements in the world are parametized, as far as this analysis is concerned. Those elements treated as determining the parameters should be such that they are either 1) in fact remotely connected with the phenomena under study or 2) closely related to the phenomena under study but change very slowly and thus can be considered as constants in analysis of this particular phenomena. There will be a set of phenomena which are considered to determine the parameters for almost all problems of economic analysis: e.g. the technology of a society, the tastes of individuals, the social structure are examples. There are phenomena which are considered as determinents of the parameters for the particular problem only: the distribution of income in society in the demand curve cited above. Of course, if you alter the distribution of income, the values of the constants

will be changed; but in most problems the distribution of income will be considered as a given. Due to practical limitations on the number of variables that can be considered at one time (a failing of human minds) the parameters of any theory contain most of the elements of that portion of the world being studied.

By means of parametrization we have eliminated all but a few variables; we now need to connect these variables by economic relations. We must first decide which of these variables are to be explained within the system being constructed and which are to be taken as determined from outside the system. The variables to be determined within the system are called endogenous variables: outside the system, exogenous variables.

It is necessary to distinguish more precisely the exogenous variables from the variables determining the parameters. In the demand curve considered above, we specifically connected the quantity of butter taken ( $X_B$ ) with

- 1) the price of butter ( $p_B$ )
- 2) the price of margarine ( $p_M$ )
- 3) the level of income ( $Y$ )

In order to draw a two dimensional graph we said that given the value of the parameters ( $a_0, a_1, a_2, a_3$ ), we got a line relating  $X_B$  and  $p_B$  for each specified value of  $p_M$  and  $Y$ .  $p_M$  and  $Y$  are in this case treated as exogenous variables. In this example we are treating income as an exogenous variable, at the same time that we are treating the distribution of income as an element determining the parameters. That is, our equation contains the hypothesis that a change in income will have a determinate result upon the relation between the price of butter and the quantity taken, whereas we make

no such assertion about a variation in the distribution of income. Therefore, for our predictions to be valid, the distribution of income must remain essentially constant. Otherwise, the shape of the demand curve will be changed.

The exogenous variables are specified elements which enter an economic relation, whose values are not to be explained by the relationship. The level of income enters the demand function of butter in a quite specific manner; however, the price and quantity sold of butter is but a small element in the level of income. Therefore, in a model which is designed to explain the price and quantity sold of butter, we take account of the dependence of the market equilibrium upon the level of income by specifically including it. But by making it an exogenous variable we recognize the essential independence of the level of income from the equilibrium in this particular market. We may at times treat a variable as exogenous because we are analysing a portion of a more complete system of relations, and this portion may be dependent upon the values of variables determined in the remainder of the system. Strictly speaking, in order to analyse the relations in a part of a specified model, we may treat a variable as exogenous which in a closely related problem we would naturally treat as an endogenous variable. By labelling a variable exogenous, we eliminate it from the main body of a theory. This means that all of the results are based upon a specified value of this variable, and the manner in which the endogenous variables react to changes in this exogenous variable becomes a leading result of the analysis.

As a result of parametrization and the selection of exogenous variables, there remain relatively few endogenous variables. The

function of economic theorizing is to state explicitly the interrelations among these endogenous variables, as well as the connection between these endogenous variables and the exogenous variables. Each specification of a relation yields an equation connecting the variables. If there are  $n$  endogenous variables, the  $n$  such equations will, if they satisfy certain formal properties dealing with their independence, yield a given set of  $n$  values for the endogenous variables; these  $n$  values of the variables will be (depending upon the functional form of the relations) the only set of values which will satisfy all of the relations simultaneously. These values are the equilibrium values; therefore the idea of equilibrium is the simultaneous satisfaction of all of the specified relations among the endogenous variables.

We can fit the familiar idea of market equilibrium into the above conceptual apparatus. For a given market, we assume a well-defined commodity, and a corresponding set of firms producing the commodity. The factors determining the parameters are the given tastes (utility surfaces) of the households and the production functions of the firms. The exogenous variables are the prices of all other commodities, and the prices of the factor inputs. The endogenous variables are the price and quantity of the given commodity. We specify a demand function  $q = f(p)$  and a supply function  $q = d(p)$ . The simultaneous solution of these two equations [the intersection of the schedules on the familiar supply-demand diagram] gives us the equilibrium price and quantity on this particular market.

Let us assume that the demand curve shifts. This may be imputed to either a) a shift in the price of another commodity or



b) a change in tastes. Our theory does not permit us to predict the effect of a change in tastes. However, the change in the price of another commodity is an economic event; and economists have an apparatus to handle it. We now write the demand curve for the particular commodity under analysis  $q_1 = f(p_1, p_2)$ , the supply curve as  $q_1 = \phi(p_1)$  and we can write  $p_2 = \bar{p}_2$ , ( $\bar{p}_2$  is an exogenous variable); that is, the price of the second commodity is determined outside our system. For each specified price of the second commodity we have a determinate equilibrium in our particular market. [For each price of the second commodity, there is a different demand schedule, intersecting the same supply schedule.]

We could also set up a more inclusive system determining both  $p_1$  and  $p_2$

$$(1) q_1 = f_1 (p_1, p_2)$$

$$(2) q_1 = \phi_1 (p_1)$$

$$(3) q_2 = f_2 (p_1, p_2)$$

$$(4) q_2 = \phi_2 (p_2)$$

Here, we have a system of four equations, four unknowns and, given that the equations are of the correct form, we can solve for  $q_1$ ,  $q_2$ ,  $p_1$ ,  $p_2$ ; our four endogenous variables. The extension to  $n$  endogenous commodities, with their  $2n$  endogenous variables is obvious. If a system of endogenous variables and relations connecting them is such that any change in the equilibrium values can be imputed only to changes in elements which are non-economic, we can call the system complete, i.e. a complete system contains no exogenous variables.

A practical problem enters: in a science with as many variables as economics, a complete system is tremendously complicated. Therefore, such complete systems are of interest essentially to provide a background of logical (internal) consistency for economic analysis.