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Microeconomic Theory

23.1 BACKGROUND

Improvements in technique

The most obvious difference between the economic theory of the post-war period and that of the previous period is the enormous increase in the use of mathematics, combined with the use of more advanced mathematical techniques. Given that the system of static, competitive equilibrium analysis was established in its essentials by 1939, it is tempting to argue that what has happened since then amounts to little more than the application of superior techniques at the expense of attempting to derive new economic insights. Whilst there may be some truth in this, however, it would be wrong to dismiss modern economic theory on these grounds without attempting to see what has been achieved and how.[1]

Advances in technique are relevant for the history of economic analysis only in so far as they affect the content of economics. Since 1939 there have been several areas where improvements in technique have been very important in affecting the way in which economic inquiry has been undertaken. Two types of development need to be distinguished. Firstly there are mathematical developments which enable results to be derived more elegantly and at a greater degree of generality, and which permit a more unified treatment of the theory than would otherwise be possible. Examples of such techniques include the theory of convex sets and certain aspects of duality theory. Such developments, however, despite their producing enormous changes in the way economic models are handled, and despite their improving economists' understanding of these models, have had little effect on the way the economy has been viewed. Secondly, there are those developments which have had a fundamental effect on the way the economic system is conceived. These include linear models, game theory and the theory of choice under uncertainty.[2]

Linear models

In *Linear Programming and Economic Analysis* (1958) Dorfman, Samuelson and Solow commented that economists had been doing linear economics for 40 years without being conscious of it. They argued that economists had for a long time passed over the linear aspects of their problems as "obvious, trivial and uninteresting".[3] This had changed in the two decades prior to the book's publication, when a variety of new methods had been developed, all

dependent on the linear structure of certain economic problems[4] – in particular input–output analysis, linear programming and game theory.

Input–output analysis, outlined by Leontief in 1936, and more fully expounded in *The Structure of the American Economy, 1919–29* (1941) was, in Leontief's words, "an attempt to apply the economic theory of general equilibrium – or better, general interdependence – to an empirical study of interrelations among different parts of a national economy."[5] Of Leontief's three sets of equations, two were inherently linear: the conditions that an industry's net output must, in static equilibrium, equal the consumption of that industry's output by all other industries plus final demand; and that the price of an industry's output equal the value of the inputs used in producing it. What turned the problem into a completely linear one was the assumption that the technical coefficients relating outputs to inputs were fixed.[6] The implications of this approach were not simply that it made possible statistical estimation of relations between industries, important though this was, but that it stressed the complementarity rather than the substitution between factors, and that it pushed intermediate goods to the forefront. The importance of complementarity relative to substitution was an empirical issue.[7] The emphasis on intermediate goods became clearer when, during the war, Leontief analysed an "open" system: one in which final demand was taken to be exogenous. In such a model it was possible to use an input–output model to examine the effects of, for example, a change in military expenditure, not simply through analysing its direct effects, but also through working out its implications for the use of intermediate goods, such as chemicals and steel. It was possible to examine the effects of changes in the composition of demand on production in various industries, and on demand for labour.

Only a little later came the first work on linear programming, again inspired by practical problems, the "transportation problem" (given a certain number of factories and a number of consumers who must be satisfied, all in different locations, how can production be organized so as to minimize transportation costs?)[8] and the "diet problem" (what combination of different foods will give essential nutrients at minimum cost?). Though both problems were solved in 1941, the important developments came with the work of Koopmans (1947a) and Dantzig (1951) who, rediscovering the transportation problem in their work for the US Navy and Air Force, posed and solved the more general linear programming problem. Two developments were of particular importance. One was the simplex method, which provided a means of solving more than a very simple problem (Dantzig, 1951); and, most important of all, the theory of duality (Gale, Kuhn and Tucker, 1951). The theory of duality was important because of its economic interpretation. Suppose the original problem is to maximize profit subject to given factor supplies. The solution to the dual problem yields the value of each of the factors. Hicks interprets this as showing that the price system is inherent in the economic problem, not something brought in from outside.[9]

Game theory

Though it initially arose as one aspect of linear theory, game theory has been sufficiently important in the development of post-war economics to merit separate attention.[10] The theory of games was first outlined by von Neumann in 1929, but the work which brought it to the attention of economists at large was *The Theory of Games and Economic Behaviour* (1944) written with Morgenstern. After discussing the use of mathematical methods, von Neumann and Morgenstern open their book with a discussion of rational behaviour.[11] Following the lead given by Menger and Böhm-Bawerk in placing emphasis on exchange between a limited number of individuals, they argue that rational behaviour must be analysed in a situation where "strategy" is important: where one individual's action can influence the actions of others, and where there is the possibility of coalitions being formed. This is a situation that von Neumann's theory of games was designed to analyse.

In simple games the minimax criterion was adopted as the criterion for individual rationality: each player chooses the strategy which keeps the maximum loss (the actual loss depending on the other player) as low as possible. The device of choosing mixed strategies (for example tossing a coin to decide which strategy to play) was introduced to ensure that an equilibrium could always be found. Probably of more significance for economic theory, however, was their analysis of bargaining, the strength of their approach being that they analysed the conditions under which coalitions would be formed. To do this they introduced the concept of "dominance":

> x dominates y [x and y are two allocations of individual gains] when there exists a group of participants each one of whom prefers his individual situation in x to that in y, and who are convinced that they are able as a group – i.e. as an alliance – to enforce their preferences.[12]

The significance of the concept of dominance is that if one outcome (call it y) is dominated by another (x) then y will never occur, for there will be a group which will not accept y, for it prefers x, and believes it can achieve x. What von Neumann and Morgenstern described as the "solution" to the game was not a unique outcome, but the set of all the outcomes not dominated by outcomes which were themselves feasible.

Since the appearance of *The Theory of Games and Economic Behaviour* much work has been done by economists and others on both co-operative and non-co-operative games. Particularly important have been Nash's (1950) solution for a non-co-operative game, a generalization of the "Cournot duopoly equilibrium"; the concept of the "core", first defined by Gillies (1959);[13] and various solution concepts offered for co-operative games (e.g. Nash (1953).[14] The core, the set of allocations not blocked by any possible coalition,[15] was applied to market equilibrium by Shubik (1959) and proved useful in understanding the nature of competitive equilibrium, for it could be shown rigorously that, as Edgeworth had argued some 80 years earlier, the core (Edgeworth's contract curve) contained any competitive equilibria;

and that as the number of traders increased the core shrank until in the limit only competitive equilibria remained. Competitive equilibria were thus the only feasible equilibria in an economy where all traders were too small to have any bargaining power.[16]

Choice under uncertainty

One of the most important characteristics of post-war microeconomics is the widespread use of various techniques for dealing with choice under uncertainty. Though such techniques can be found in earlier work[17] they were not widely used. Three, related, approaches to the problem of choice under uncertainty have been particularly important. The first is that due to von Neumann and Morgenstern (1944), who developed a theory of expected utility maximization, basing this on a series of axioms about human behaviour.[18] In the early 1950s there was controversy over these axioms, for they implied that a cardinal utility index could be constructed. It was from the appearance of Savage's *The Foundations of Statistics* (1954), which contained a more complete statement of the axioms on which the theory was based that the theory began to be much more widely accepted.

The second approach is Arrow's (1953) "state preference" theory. This distinguishes goods according to the "state of nature" in which they are available. An example of such a "contingent commodity" would be "an umbrella if it is raining". Individuals are assumed to have preferences between such goods. Though state preference theory is quite compatible with von Neumann–Morgenstern expected utility maximization, it provides a more useful way of tackling certain problems.

Finally there is the "mean–variance" approach, used in particular by Tobin (1958) and Markovitz (1959) to analyse the demand for securities. Here it is assumed that an individual's utility depends on the mean and the standard deviation (or variance) of the return on a portfolio of assets. This is equivalent to the von Neumann–Morgenstern approach only if the individual's utility function has certain special properties. Though many economists consider these special properties unacceptable, the mean–variance approach nonetheless continues to be used because of its simplicity.

Aggregation

For a variety of reasons economists in the post-war period have been much more aware of aggregation problems than were their predecessors: improved mathematical techniques made it possible to analyse such problems much more thoroughly, but above all aggregation was unavoidable in statistical work. Two theorems on aggregation were widely known: those of Leontief and Hicks. In *Value and Capital* Hicks proved that where the relative prices of a group of commodities were constant, this group of commodities could be treated as a single commodity. Slightly more general was Leontief's theorem (1947) that a group of commodities could be aggregated if the marginal rate of substitution between any two commod-

ities in the group was independent of the quantity of any commodity outside the group. These were not conditions which could generally be assumed to be satisfied. Though similar results were produced in other contexts (e.g. Gorman's (1953) conditions for aggregating individual demands and Fisher's (1969) conditions for aggregating production functions), the conditions under which aggregation was possible were so strict as to emphasize that it was not in general possible.[19] For example, the aggregation of consumers' demands to obtain a market demand curve with similar properties is, apart from special cases, possible only where all the individuals are identical, or have homothetic preferences (loosely, this means that each indifference curve is an enlarged or reduced version of any other indifference curve).

23.2 GENERAL COMPETITIVE EQUILIBRIUM

Samuelson's Foundations

The work which in a sense laid the foundations for contemporary economic theory was Samuelson's *Foundations of Economic Analysis* (1947). Though published eight years after Hicks' *Value and Capital* it was independent of it, parts having been written as early as 1937. From the start, Samuelson made full use of mathematics, arguing that "the laborious working over of essentially simple mathematical concepts" should be regarded as unrewarding mental gymnastics of a particularly depraved type.[20] He aggressively and explicitly reversed Marshall's view on the role of mathematics in economics.[21] This stress on mathematics, however, constitutes only the background to Samuelson's contribution, of which three aspects are particularly important.

(1) He defended the use of the concept of equilibrium, arguing that many problems could be viewed as maximization or minimization problems. The theory of consumer behaviour and the theory of the firm were, for Samuelson, simply applications of the theory of constrained maximization. Not only did this framework reveal a unified structure underlying apparently diverse problems, but it was a source of predictions. For example, the fact that demand functions described the solution to a constrained maximization problem might in itself be enough to make it possible to say something about their properties.

(2) The task of economic theory was argued to be the derivation of "operationally meaningful" theorems: hypotheses about empirical data which might conceivably be refuted.[22] Whatever the merits of this from a methodological point of view,[23] its significance was that it led him to stress the importance of comparative statics: it was not enough to enumerate the factors influencing the price of a commodity, for example, if nothing could be said about how changes in these factors would cause the price to change. As regards such predictions, Samuelson found two sources of information. Some theorems about comparative statics could be derived from the

assumption of maximizing behaviour on the part of individuals, in particular from the second order conditions for an optimum, but more important were those derived from stability conditions. For example, in Marshallian theory where, for a given output, the market sets the price, an equilibrium will be stable if the supply curve cuts the demand curve from below.[24] Given this information we can immediately deduce that a rise in demand will lead to an increase in output. This relationship between stability conditions and comparative statics results was named by Samuelson the "correspondence principle".[25] The correspondence principle, however, turned out to be much less useful than Samuelson had claimed. The main reason for this is that where consumers are maximizing their utility, and producers are maximizing their profits, the conditions for stability turn out to be equivalent to the conditions for the existence of an equilibrium. Stability conditions are thus superfluous.

(3) Finally, there is Samuelson's stress on the need to analyse stability in terms of an *explicit* dynamic process. It was not enough, according to Samuelson, simply to ask whether, for example, a fall in the price of a commodity raised excess demand for the commodity. It was necessary to specify a process linking price changes to excess demands, and to examine the conditions for this process to converge to an equilibrium. Although Samuelson's treatment of dynamics was not new (he acknowledged a debt to Frisch (1935–1936)[26] it was his approach which became the standard one.

The Arrow–Debreu model

A problem not dealt with by Samuelson or Hicks was that of the existence of a competitive equilibrium, the main contributions here being made in the 1950s. The main paper here was by Arrow and Debreu (1954), who produced a much more general existence result than those produced by Wald and his contemporaries in the 1930s.[27] In particular Arrow and Debreu started from assumptions about consumers' preferences, rather than marginal utility functions, and they used more general assumptions about technology than the fixed coefficients assumed by Wald and von Neumann. During the 1950s various attempts were made, working within the same basic framework, to generalize these results, the economists involved including McKenzie, Gale, Nikaido and Uzawa.[28] The canonical statement of what has become known as the Arrow–Debreu model was provided in Debreu's *Theory of Value* (1959).

Because of its importance to contemporary economics it is important to be clear about what this model involves, about the conclusions drawn from it, and about what the model does not do. Of particular importance is the way goods are defined. A good is defined in terms of *four* attributes: physical characteristics; location; date of delivery; and the state of nature in which it is available.[29] Thus, for example, "black umbrellas delivered in London on St. Swithun's day 1995 if it is raining" would be a different good from similar umbrellas delivered at the same time and place in the event that it is not raining. The term used to denote goods defined in this way is

"dated, contingent commodities", for their availability is contingent on certain events (as is, for example, a payment under an insurance contract). The assumption is then made that *all* goods defined in this way have markets. This amounts to assuming that there is a *complete set of futures and insurance markets*, which in turn means that agents (firms and households) can determine their entire production and consumption plans, for they know the prices of all goods in all future periods, and they can insure themselves against all eventualities.

Arrow and Debreu were able to prove that, provided firms' production sets and consumers' preferences exhibited certain properties, an equilibrium would exist for such an economy.[30] Later work in the 1950s was concerned with proving the existence of an equilibrium under weaker (less restrictive) assumptions about production sets and household preferences. The basic framework was left unchanged.

To see the significance of this result we have to see it in conjunction with the so called fundamental theorems of welfare economics derived a few years earlier about the relationship between Pareto efficiency and competitive equilibrium.[31] In 1951 Arrow and Debreu had shown (1) that any competitive equilibrium must be Pareto efficient, and (2) that any Pareto efficient allocation could, by an appropriate redistribution of endowments (the initial stocks of goods, including factors of production, owned by households) be achieved as a competitive equilibrium. It could thus be claimed that the Arrow–Debreu existence result provided a rigorous demonstration of the conditions under which the "invisible hand" would work and that they had shown that it is *possible* to describe an economy in which resources are allocated in an orderly fashion. It is important to note, however, that no claim has been made that these results describe *any* actual economy. Indeed, it can convincingly be argued that they could not possibly describe any actual economy.

Compared with earlier work the novelty in this approach rested in the introduction of dated, contingent commodities to deal with the problems of time and uncertainty. This treatment of these problems is, however, unrealistic, not least because it provides no role whatsoever for money, and there is no reason for a market in firms' shares to exist. This is because when the economy "opens", transactions can be undertaken governing sales and purchases at all future dates. There is no reason for markets to continue to operate after the opening period – this is the result of postulating a complete set of futures markets.

If the Arrow–Debreu model is so patently unrealistic, why is it used? One reason is simply that it renders the problem of proving the existence of an equilibrium tractable. By dealing with time and uncertainty in this way, the problem is reduced to one of static equilibrium, for all market activity takes place at the beginning of the economy's life. The complete set of insurance markets removes problems of uncertainty and expectations. The second reason, however, is more fundamental, namely that the Arrow–Debreu model helps redefine the real issues facing economists as why the sufficient conditions for equilibrium do not hold. Because of this the Arrow–Debreu

model provides a benchmark with which other equilibrium concepts can be compared. For example, though it can be argued that it has little in common with Smith's use of the term, it has been claimed (e.g. Hahn, 1982c) that the Arrow–Debreu model shows what we need to ensure that the "invisible hand" works. In particular, it shows the need for a full set of markets. This provides a framework for seeing why the "invisible hand" breaks down in other models: the absence of Pareto optimality in more "realistic" models can, for example, often be explained in terms of missing markets.

Stability

In the 1950s much work was done not only on the existence, but also on the stability, of competitive equilibrium. Here the starting point was Samuelson's work – the approach adopted was to specify a specific dynamic process and to examine the conditions under which this process would converge on an equilibrium. One of the first tasks was to reconcile Samuelson's stability conditions with Hicks' which, though not derived from an explicitly dynamic model, had an economic interpretation. It was shown by Smithies (1942) and Metzler (1945) that under some circumstances the two were equivalent.

In analysing stability it was necessary, as Samuelson had shown, to make assumptions about the specific dynamic process involved. Here the benchmark was the *tâtonnement*: the imaginary process, taken from Walras, whereby an auctioneer raises or lowers prices according to whether excess demands are positive or negative. A crucial aspect of the process is that no transactions take place until markets are in equilibrium. The reason for these assumptions was not the realism of the process they describe, but theoretical problems. If agents' plans are inconsistent (as must be the case if supply and demand are not equal) it is very difficult indeed to say how much will be bought and sold. In addition, given that all agents are price-takers (there is perfect competition), who, if there is no auctioneer, sets prices?

In the 1950s a series of papers appeared on the stability of *tâtonnement* processes. However, although the results were more rigorously proved, and more general, there was, as regards economically interesting stability conditions, little advance beyond Hicks' condition that all goods must be gross substitutes. That nothing more general was likely to be available was made clear by Scarf (1960), who produced a range of interesting cases which were unstable. Further work in the early 1970s confirmed that stability was something that could be proved for only very special cases.[32] The search for more and more general stability conditions was a waste of time.

Despite the problems involved, attempts were made to analyse non-*tâtonnement* processes. For example, Hahn and Negishi (1962) analysed a process where exchange took place out of equilibrium, this being governed by the condition that where a good was in excess demand (supply) overall, no agent was constrained in the amount he or she could sell (buy). Another example is Uzawa (1962), who investigated a process, analogous to that described by Edgeworth, where exchange takes place whenever two agents

can do so to their mutual advantage. Although, however, it was possible to deduce conditions under which such processes converged upon a competitive equilibrium, this approach, despite its potentially greater realism, did not get very far. The main reason for this was the lack of any firm criterion as to what should happen out of equilibrium.

Alternatives to the Arrow–Debreu model

One of the most obvious alternatives to the Arrow–Debreu model is to consider an economy with an incomplete set of markets, in particular one with an incomplete set of futures and insurance markets. This is of fundamental importance, for it provides a role for money. The reason for this is that, if some of these markets are missing, decisions cannot all be taken at once. Trading will need to take place all the time, not merely in the beginning. Economies like this, where trading takes place at every date, were named, by Radner (1968), *sequence economies*. Such an economy was considered by Hicks in *Value and Capital*. Hicks' work was important because he pointed out the importance of the way in which expectations are formed, distinguishing between two types of equilibrium: a *temporary equilibrium*, in which expectations of the future are taken as exogenous; and a *perfect foresight equilibrium*, in which expectations are correct.[33] One virtue of this approach, apart from its being clearly less unrealistic than the Arrow–Debreu model, is that it is a prerequisite for constructing a model of a monetary economy. Money (an asset of no intrinsic value, held only because of what it can buy) only makes sense if markets are open at a sequence of dates, though other conditions are needed as well, such as the existence of transactions costs. Research along these lines was widespread in the 1970s. The main issue investigated was that of the conditions under which an economy would have an equilibrium in which the price of money was positive.[34]

The temporary equilibrium models discussed so far may allow for the possibility of money, but they are still inadequate to explain how Keynesian problems might arise, for the assumption that markets are in equilibrium rules out the possibility of unemployment in the sense of supply labour exceeding the demand. One way of introducing the possibility of unemployment is to assume that prices are, at least temporarily, fixed. If prices cannot adjust to equate supply and demand, either buyers or sellers will be unable to trade as much as they wish at the prevailing prices. In the former case, for example, some goods will be rationed. If agents are rationed in one market (for example, suppose that households cannot sell as much labour as they wish) they will have to adjust their demands or supplies in other markets (for example, reduce their demand for consumption goods). Although these ideas were developed in the concept of macroeconomics,[35] they lead to an equilibrium concept which can be applied in more general models.

Although the first microeconomic analysis of an equilibrium with rationing was that of Glustoff (1968) the most widely used notions of

equilibrium with rationing are those of Dreze (1975) and Benassy (1975).[36] In formulating such models there are three problems to be solved: (1) to decide what information agents have about the quantities they can buy or sell when markets are not in equilibrium (note that in a market clearing model this problem does not arise, for prices contain all the relevant information); (2) to decide how the constraints that agents perceive affect their supplies and demands;[37] and(3) to specify a scheme whereby agents are rationed (for example, do all workers work short hours, or do some work as much as they wish, with others totally unemployed). It is differences in the answers suggested to these problems that account for the differences between Dreze and Benassy equilibria, though the problem they are tackling is fundamentally the same.

Attractive as these models may seem in providing a rigorous framework for discussing Keynesian phenomena, they suffer from very serious drawbacks, in particular from two, possibly related, problems. The first is that they fail to explain why prices do not adjust to clear markets. The second is that if agents face constraints on the amounts that they can buy and sell, then competition cannot be perfect. If, for example, there is a maximum to the amount a firm can sell, then its demand curve cannot be completely horizontal. This observation leads naturally into the suggestion that monopolistic competition rather than fix-price equilibrium may be a better framework. With the exception of an early paper by Negishi (1960) research along these lines dates from the 1970s, examples being Benassy (1976), Grandmont and Laroque (1976) and Hahn (1978).[38]

23.3 FURTHER DEVELOPMENTS

The theory of choice

The theory of general competitive equilibrium, whether in its Walrasian or Arrow–Debreu form, is based on the assumptions that consumers and firms know the situation confronting them, and that they have no influence on the market. Even theories of growth[39] make sense only in such a context. The treatment of such firms and consumers has remained, in its essentials, unaltered since Hicks' *Value and Capital* and Samuelson's *Foundations*. The axioms on which consumer theory is based have been worked out more thoroughly, and more efficient techniques are available for deriving results from it. Though the result of this is that the theory is now much better understood, it can be argued that the effort put into work such as Hicks' *Revision of Demand Theory* (1956) has not been very well rewarded.[40]

Although the fundamental assumptions involved have changed little, the range of problems to which consumer theory has been applied has increased to such an extent as to make the theory significantly different from what it was 40 years ago. This will be illustrated with three examples.[41] The first of these concerns the supply of labour and the choice between consumption and leisure. An interesting aspect of this example is that it is one where the

typical budget constraint will be non-linear: if the household has any non-labour income, for example, non-linearity arises immediately from the constraint on the number of hours in the day. Possibly more important, however, is the fact that most of the interesting applications of consumer theory involve non-linear budget constraints (for example, the implications of different wage structures, or the impact of the tax and benefit systems). The resulting emphasis on the form of the budget constraint, rather than on the nature of preferences, as the critical factor influencing consumer behaviour, applies not simply to labour economics, but to many applications.[42] Also important is the use of consumer theory to analyse the question of labour supply over time, raising the issue of investment in education, usually analysed in terms of "human capital". Although modern discussions of human capital started a few years before this,[43] the main stimulus to work in this area came from Becker's *Human Capital* (1964).

The emphasis on constraints rather than preferences is also a feature of the second example, theories of the household "production function". Becker (1965) proposed a theory in which the goods on which utility depends (such as eating a meal) require both purchased goods (food) and time (for preparation and eating). Households thus face both time and budget constraints, which means that the opportunity cost of an activity depends on the inputs it requires, the cost of any goods required and on the value of time. Related to this is Lancaster's (1966a and b) theory,[44] where utility is assumed to depend not on goods consumed, but on "characteristics". Goods (e.g. baked beans) comprise bundles of characteristics (flavour, nourishment). Consumers choose their preferred bundle of characteristics, achieving this by an appropriate choice of goods.

The final example is the theory of rationing, to which wartime controls provided the stimulus.[45] The main interest here has been in "spillover effects" – with how a change in consumption of a rationed good affects demand for unrationed goods. Although it was in the early 1970s that interest in this subject was at its height, the foundations for subsequent work were provided by Tobin and Houthaker (1951). They had shown that if one commodity were rationed, the elasticity of demand for other commodities would be reduced. Whether a change in one ration increased or reduced demands for other commodities depended on whether they were substitutes for, or complements to, the rationed good. During the 1950s interest in rationing theory waned, for obvious reasons, but it revived in the 1970s in response to work on equilibria with rationing.[46] As with the other two examples, the basic consumer theory here is identical to that of Hicks and Samuelson: the novelty lies in its application to new situations.

Choice under uncertainty

As this problem was most often handled using expected utility maximization together with a von Neumann–Morgenstern utility function, attention was confined to what Knight[47] called risk – measurable uncertainty. With

very few exceptions[48] the problem of choice under circumstances where the individual has no information on which to base a calculation of probabilities was neglected. Given this, existing theory could be reworked, replacing utility or profits with expected utility or profits, and with random parameters introduced into some of the constraints. For example, it is a simple exercise to assume that the firm faces a randomly shifting demand function, with a given probability distribution, and to work out conditions under which expected profit is maximized.[49] To interpret such results, however, we need a way of measuring risk and attitudes towards it, so that we can investigate why the introduction of risk affects the results. Various measures of both risk and risk aversion were developed, such as the Arrow–Pratt measure of risk aversion, and the Rothschild–Stiglitz measure of risk.[50]

Given such a framework a number of issues can be tackled. One of them is risk – both how it affects decisions, and how it is shared between individuals and firms. The obvious example here is insurance, but it is important to point out that insurance is not the only mechanism for transferring risk from one individual to another. Consider the wage contract between workers and a firm, when the demand for the firm's product is uncertain. If a fixed wage is specified, the firm bears the entire risk, whereas if wage rates vary with the price of the product the risk is shared with the workers. Such considerations have been applied to situations as diverse as labour contracts, in an attempt to explain the stickiness of wage rates,[51] to the issue of labour managed firms,[52] and tenancy agreements in underdeveloped countries.[53]

The economics of information

In recent years much attention has been devoted to the question of how markets work when information is limited. This is a complicated question, for not only is there the problem of how information is acquired, but it is frequently necessary to allow for imperfect competition. Consider the case, for example, where consumers have limited information about the prices charged by different firms, a case first analysed by Stigler (1961). In such models the optimal strategy for consumers to follow is often to set a "reservation price", buying from the first firm they encounter which offers a price below this. The higher are the costs of searching, the lower the reservation price will be. If consumers are different, and have different reservation prices, then any individual firm will face a downward-sloping demand curve. In any period a number of consumers will come to this firm, and the higher its price, the greater the number of customers who will choose not to buy, but to continue searching for a cheaper price. Competition is thus necessarily imperfect. The outcome of such processes depends on the precise assumptions made about how much firms and consumers learn: it might, for example, be either the monopolistic or the competitive price.[54]

Asymmetric information

Once uncertainty is introduced there arises the possibility that not only will information be listed, but that different agents will have access to different information. This situation is known as one of asymmetric information. In many situations it could be argued that asymmetric information is the rule, because for an individual uncertainty comprises not only uncertainty about the "state of nature", but also uncertainty as to the preferences, and hence the behaviour of the other agents in the economy. This raises, as was established in the 1970s, fundamental issues concerning the way in which markets operate. Two particular problems need mentioning: moral hazard, and adverse selection.

The problem of moral hazard can be illustrated by an insurance contract. If an individual is completely insured, he or she will have no incentive to avoid accidents, and may thus be less careful than if he or she were uninsured. Insurance may thus affect the probability of an accident. This problem, however, is *much* more general: it is related to the issue of whether individuals can be provided with an incentive to tell the truth, or not to cheat.[55]

Adverse selection can also be illustrated with reference to insurance markets, though this problem too is much more general. Suppose an insurance company offers medical insurance at a premium appropriate to the health of the average member of the population. Those whose health is very good will decide that the policy is too expensive to be worth buying.[56] The result is that the average health of those buying the insurance will be *worse* than that of the population as a whole. This problem, known as adverse selection, can arise whenever the quality of a commodity traded is uncertain, and where there is asymmetric information. For example if the seller of a used car knows how good it is, but potential buyers have no means of assessing the car's quality until after they have bought it, the average quality of used cars offered for sale should be worse than the average quality of cars of the same age and type.

A seminal paper here was Akerlof's (1970) model of the market for "lemons" (poor quality used cars). His conclusion was that, given certain, not unreasonable, assumptions, trade would be impossible. The only feasible equilibrium price was zero. The argument is quite simple. Suppose the market price for cars of a certain age and type were positive. Because sellers know the quality of the cars they are selling, cars worth more than this will not be offered for sale. The average value of cars offered for sale will therefore be less than the market price. Given that buyers have no idea of the quality of the particular car they are buying, buyers will be prepared to pay only this average price. They will not be prepared to pay the market price. A positive price cannot, therefore, be an equilibrium price.

A still more fundamental result is that of Rothschild and Stiglitz (1976), who investigated the possibility of equilibrium in an insurance market. They assumed that the insurance company had no means of telling whether potential purchasers of insurance fell into a high or low risk category. Rothschild and Stiglitz were able to show that if insurance companies were to offer only a single type of contract, no equilibrium would exist, not even

one with a zero price. An equilibrium, might, however, exist if two types of policy were offered, designed so that high risk customers would purchase one type of policy, and low risk customers the other. For example, one type of policy might have a lower premium, but with the customer being responsible for a certain fraction of any claim. High risk individuals might find such a policy unattractive (remember, individuals are assumed to know their own health). Under some circumstances, however, even such a *separating equilibrium*, as it is called, may not exist. Rothschild and Stiglitz were also able to show that if such an equilibrium were to exist, some individuals would be rationed: low-risk individuals would find that they were unable to purchase as much insurance as they wanted to buy. These results, that an equilibrium may not exist, that even if it does there may be more than one price in equilibrium, and that agents may face quantity constraints, have been obtained in a variety of models of asymmetric information.[57]

Offering two types of policy, designed to attract different types of customer, is an example of *screening*: of agents finding ways of distinguishing high quality from low quality goods or customers. An alternative would be for sellers to find ways of *signalling* the quality of their product (guarantees, or brand names, for example). Such issues have been extensively discussed in recent years.[58]

A characteristic of the markets discussed above is that prices convey information. A natural question to ask, therefore, is how much information can prices convey? As an example, consider a model put forward by Grossman and Stiglitz (1980). Grossman and Stiglitz assume that there is some uncertainty about which firms can, if they are prepared to pay the cost, become fully informed. If firms choose to acquire this information, it will affect their behaviour, and hence the market price. Suppose that every firm were to become informed. For any individual firm the incentive to become informed would disappear, for it could deduce all the information it needed from observing the prices produced by the behaviour of its fully-informed competitors. Thus there cannot be an equilibrium in which firms are fully informed: firms would have an incentive to stop acquiring the information. Now suppose that firms all chose not to buy the information. In this case any firm would find it profitable to buy the information: because other firms are uninformed, prices cannot carry any information. Thus a situation where no firms buy the information cannot be an equilibrium either. No equilibrium exists, neither one in which firms choose to become informed, or one in which they do not. Now suppose that there is some additional uncertainty, which no firm can predict. This "noise" may, if it is sufficiently large, serve to prevent uninformed firms from deducing the information they wish to know from prices. They will thus choose to become informed (or to remain uninformed if the costs of the information are too high), and an equilibrium may exist. Equilibrium is thus possible only where prices fail to convey all the relevant information. This shows that, if information is costly to acquire, there will be a limit to the amount of information that can be carried by price signals, and that a market equilibrium may fail to exist.

Transactions costs

An area which has received considerable attention in the post-war period is that of transactions costs. A seminal article here was Coase's "The nature of the firm" (1937) in which he argued that transactions costs provided a way of understanding the firm. Coase argued that the characteristic feature of the firm was that, within it, decisions about the allocation of resources could be made administratively, rather than through the market.[59] This raises the questions of why such "islands" of conscious planning should exist, and why their scope varies so much between industries.

Coase found the answer to these questions in *transactions costs*. Organizing production through the market is not costless: relevant prices have to be discovered, and contracts have to be negotiated. In addition there are costs arising from uncertainty and from taxation (which may apply to market transactions, but not to non-market ones). Against this have to be set the costs of organizing production within the firm. Profit maximization implies that,

> a firm will tend to expand until the costs of organising an extra transaction within the firm becomes equal to the costs of carrying out the transaction by means of an exchange in the open market or the costs of organising in another firm.[60]

The transactions cost approach which has developed from this follows Commons[61] in taking the individual transaction as the unit of analysis. The economic problem is thus seen as how to organize transactions so as to promote efficiency. It is a hallmark of the approach that the emphasis is on comparing *alternative* modes of making transactions, rather than on comparisons with a frictionless ideal. Government action, for example, is merely one among many ways of organizing transactions. As such it cannot be assumed that government action can necessarily out-perform the market. To decide for or against government intervention it is necessary to compare the costs of having the government organize transactions with those of bringing transactions about through the market.

The fact that all transactions are costly implies that the allocation of property rights between individuals is far more important than if transactions were costless. In the absence of transactions costs the allocation of property rights, except in so far as it affected the distribution of wealth, would be irrelevant, for an appropriate set of contracts could enable resources to be allocated in an optimal manner. When transactions are costly this is not the case. For example, someone might retain the use of a resource that could much more profitably be used by someone else, simply because the costs of transferring the resource (finding a suitable buyer, negotiating and enforcing an appropriate contract) are prohibitive.[62]

Oligopoly

Advance in the theory of equilibrium with small numbers of buyers and sellers, each of whom has a significant influence on the market and on the behaviour of others, was limited, until the 1970s when game theory began

to be used on a large scale to tackle the problem. This is not to say that there were not advances before then. There were, but they were limited in scope. Bain (1947) proposed the idea of limit pricing, a firm choosing the highest price consistent with making it unprofitable for any competitor to enter the market. This idea was later extended by Bain (1956) and Sylos-Labini (1962) who related entry prevention to technology: increasing returns to scale could provide a barrier to entry, for new producers have either to incur high costs by producing a small output, or else flood the market, producing at lower cost, but depressing the price.

Though the theory of games has been applied to the problem of non-collusive oligopoly, the main development has been the use of bargaining theory to handle situations where agents negotiate with each other. Much recent interest has been in the theory of contracts, especially in the labour market. This is considered below.

Firms' behaviour

In most of microeconomics, firms are assumed, making due allowance for possible risk aversion, to be profit-maximizers. This assumption has, however, been questioned. One alternative is to retain the notion that firms maximize something, but to alter the maximand. This is the approach underlying much of the literature, stemming from Penrose (1959), Baumol (1959) and Marris (1964) on the growth of the firm. In this literature firms are treated as more than producers of a single product, for it is assumed that if a firm faces limits to its expansion in one market, it can diversify into other markets. Along with this went an emphasis on the separation of ownership from control in large corporations.[63] Firms were controlled not by their shareholders, but by managers, whose interests might diverge from those of the shareholders. For example, managers' salaries, their status and their power, might depend more on the size of the firm than on its profitability. Managers would, however, be constrained in their activities, for if these diverged too far from what shareholders wanted, the price of a firm's shares might fall, raising the possibility that the firm would be taken over by another firm, its managers losing their power altogether. Thus Marris, for example, assumed firms to be managed so as to maximize *growth*, subject to the constraint that the value of the firms' shares remained above some minimum level required to prevent takeover.

These models, though abandoning the assumption of profit maximization, still assume maximization of some sort. An alternative approach is to abandon the assumption of maximizing altogether. Particularly important here is the work of Herbert Simon (1956, 1957) who has denied that maximizing behaviour is, as many economists assume, synonymous with rationality.[64] Simon has distinguished between two types of rationality. (1) *Substantive rationality* defines, "behaviour which is appropriate to the achievement of given goals within the limits imposed by given conditions and constraints".[65] This is the rationality of traditional maximizing models: finding the behaviour appropriate to maximizing profits, utility, or some

other objective. (2) *Procedural rationality*, on the other hand, defines behaviour "which is the outcome of appropriate deliberation".[66] With procedural rationality the emphasis is on the *process* whereby decisions are made.

Given that searching for alternative, more profitable, strategies is costly, it may make sense to stop searching as soon as a satisfactory strategy has been discovered. This process of discovering a satisfactory (as opposed to optimal) set of decisions is what Simon calls *satisficing*. It is not that decision makers do not wish to have higher profits (or any other objective), but rather that given the costs of acquiring information, and the uncertainty as to the benefits that will result from it (perhaps there is no better strategy) maximization may not make sense.

One development from this is behavioural theories, such as those of Cyert and March (1963). Empirical evidence is collected on the decision rules used by organizations, and the implications of these decisions are investigated. A model of the firm, the behaviour of which is determined by the decision rules of its component parts, can be used to generate predictions, which can be tested.[67] An alternative approach, followed by Simon himself, is to analyse the principles underlying the search process. Simon has investigated, for example, the principles on which an efficient search for a satisficing solution could be based.

The theory of employment

An issue which has attracted much attention since the early 1970s is that of unemployment. The persistence of high unemployment has caused economists to seek an explanation, for in a competitive market the wage rate should adjust to equate supply and demand. In the attempt to explain the persistence of unemployment, economists have used many of the concepts and ideas discussed above.[68] No attempt will be made to survey this literature, but it is important to indicate some of the ways it has been tackled.

Lack of information has underlain most attempts to explain unemployment. The earliest theories were search models (e.g. Phelps, 1970) in which unemployment arises because workers take time to find suitable employment. Such models, however, explain only "voluntary" unemployment. Further progress can be made by assuming not only that information is incomplete, but also that there is asymmetric information. Firms, for example, may not know the quality of potential workers until after they have hired them. When wage offers may act as screening devices, it is possible to find further reasons why the wage rate may fail to equate supply and demand for labour. Much of the literature on signalling is concerned with the labour market.

A more recent development has been the use of bargaining models to explain why the wage rate may remain above the market clearing rate, much attention being paid to so called *implicit contracts*: contracts which are not written down. For example, if workers are risk averse but firms, being

better able to spread risks, are risk neutral, it may be in the interests of both parties to negotiate a contract in which wages fluctuate by less than the marginal product of labour. Workers could gain from being exposed to less risk, and firms might thus be able to negotiate a lower wage rate. Asymmetric information provides another reason why fixed wage contracts may be preferred. Suppose, for example, that there is uncertainty as to the demand for a firm's product. The firm may have more information about what is happening in the market than does the union with which it is negotiating. If the firm were allowed, for example, to reduce wages when the marginal product of labour fell, it might have an incentive to pretend that productivity had fallen, in order to reduce wages. A contract in which wages are fixed, but where the firm chooses how much labour to employ, may thus be preferable for the union.

23.4 CONCLUSIONS

Although the underlying theoretical framework has remained the same as that used by Hicks and Samuelson, microeconomic theory has changed substantially in the post-war period. The availability on a wide scale of new techniques has enabled economists to extend the scope of microeconomic theory to encompass issues that were previously thought incapable of formal analysis. The extension of microeconomic theory to deal with uncertainty and lack of information promises to be particularly important, not least because it calls into question some common assumptions about the way competitive markets work, such as the notion that in equilibrium agents will be able to buy and sell as much as they wish at the prevailing prices. Such work is in its infancy, but it is possible that, it may, even though it is based on the "neoclassical" assumptions of maximizing behaviour and competitive markets, change the way in which economists think about market equilibrium. Though empirical evidence may be vital, both in raising questions which need answering and in choosing between alternative theories, such a change could never be brought about without theoretical work at a fairly abstract level.