economics

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social science that seeks to analyze and describe the production, distribution, and consumption of wealth.

Definition

No one has ever succeeded in neatly defining the scope of economics. Economists used to say, with Alfred Marshall, the great English economist, that economics is “a study of mankind in the ordinary business of life; it examines that part of individual and social action which is most closely connected with the attainment and with the use of the material requisites of wellbeing”—ignoring the fact that sociologists, psychologists, and anthropologists frequently study exactly the same phenomena. Another English economist, Lionel Robbins, has more recently defined economics as “the science which studies human behaviour as a relationship between (given) ends and scarce means which have alternative uses.” This definition—that economics is the science of economizing—captures one of the striking characteristics of the economist's way of thinking but leaves out the macroeconomic approach to the subject, which is concerned with the economy as a whole.

Difficult as it may be to define economics, it is not difficult to indicate the sort of questions that economists are concerned with. Among other things, they seek to analyze the forces determining prices—not only the prices of goods and services but the prices of the resources used to produce them. This means discovering what it is that governs the way in which men, machines, and land are combined in production and that determines how buyers and sellers are brought together in a functioning market. Prices of various things must be interrelated; how does such a “price system” or “market mechanism” hang together, and what are the conditions necessary for its survival?

These are questions in what is called “microeconomics,” the part of economics that deals with the behaviour of such individuals as consumers, business firms, traders, and farmers. The other major branch of economics is “macroeconomics,” in which the focus of attention is on aggregates: the level of income in the whole economy, the volume of total employment, the flow of total investment, and so forth. Here the economist is concerned with the forces determining the income of a nation or the level of total investment; he seeks to learn why full employment is so rarely attained and what public policies should be followed to achieve higher employment or more stability.

But these still do not exhaust the range of problems that economists consider. There is also the important field of “development economics,” which examines the attitudes and institutions supporting economic activity as well as the process of development itself. The economist is concerned with the factors responsible for self-sustaining economic growth and with the extent to which these factors can be manipulated by public policy.

Cutting across these three major divisions in economics are the specialized fields of public finance, money and banking, international trade, labour economics, agricultural economics, industrial organization, and others. Economists may be asked to assess the effects of governmental measures such as taxes, minimum-wage laws, rent controls, tariffs, changes in interest rates, changes in the government budget, and so on.

Economics as a profession

In the 19th century, economics was the hobby of gentlemen of leisure and the vocation of a few academicians; economists wrote about economic policy but were rarely consulted by legislatures before decisions were made. Today, there is hardly a government, international agency, or large corporation that does not have its resident economist. According to an estimate of the National Science Foundation (U.S.), for instance, there were 11,000 economists in the United States in 1966. Clearly, much depends on how one defines the job of an economist: the list of the National Science Foundation is confined to persons whose chief competence is in any one of the recognized economic specialities. Of the 11,000 professional economists, about 4,500 were employed as teachers of economics; the rest worked in various research or advisory capacities, either for themselves, for industry, or for government. This leaves out of account many others employed in accounting, commerce, marketing, and business administration; they may think of themselves as economists, but their professional expertise falls within other fields. There are perhaps another 10,000 economists in the rest of the world—their numbers have never been counted. It would be reasonable to estimate the total number of professional economists in the world in 1970 at 20,000, a number that was apparently growing at about 5 percent per year. There were about 75 English-language journals in economics and another 25 in various foreign languages, with new ones appearing every year. This implies the publication of about 1,500 scientific papers per year, not to mention the 700 new books on economics published every year. This is indeed “the age of economists,” and the demand for their services seems insatiable.

Historical development of economics

The effective birth of economics as a separate discipline may be traced to the year 1776, when the Scottish philosopher Adam Smith published *An Inquiry into the Nature and Causes of the Wealth of Nations*. There was, of course, economics before Adam Smith: the Greeks made significant contributions and so did the medieval scholastics; from the 15th to the 18th century, an enormous pamphlet literature appeared that developed the implications of economic nationalism, a body of thought now known as “mercantilism”; for a brief period in the 18th century the French “physiocrats” developed a fairly sophisticated economic model; and several other 18th-century figures can compete with Smith for the title of “first economist.” Nevertheless, Adam Smith wrote the first full-scale treatise on economics and, by his magisterial influence, founded what later generations were to call the “English School of Classical Political Economy.”

Analysis of the market

The *Wealth of Nations*, as its title suggests, is essentially a book about economic development and about policies that promote or hinder development. In its practical aspects it is an attack on the protectionist doctrines of the mercantilists and a brief for free trade. But in the course of attacking “false doctrines of political economy,” Adam Smith was led to analyze the workings of a free-enterprise system as a governor of human activity. In a competitive market each individual, being one among many, can exert only a negligible influence on prices; each must take prices as they come and is free only to vary the quantities bought and sold at given prices; yet the sum of all individuals' separate actions determines prices. The “invisible hand” of the market, as Adam Smith was fond of saying, assures a social result that is independent of individual intentions and thus creates the possibility of an objective science of economic behaviour. Adam Smith believed that he had found, in the competitive market, an instrument capable of converting “private vices” (like selfishness) into “public virtues” (like maximum production). But this is only true if the competitive system is embedded in an appropriate legal and institutional framework, an insight that Adam Smith developed at length but that was largely forgotten by later generations. Within this great tome on the theme of rich and poor nations was contained a simple theory of value (or prices), a crude theory of distribution, an even cruder theory of international trade, and a primitive theory of money; but with all their imperfections, these were the building blocks of classical and modern economics. The book's very fecundity gave it strength because it left so much for disciples to tidy up.

Construction of a system

David Ricardo's *Principles of Political Economy and Taxation* (1817) was, in one sense, simply a critical commentary on the *Wealth of Nations*; in another sense, it gave an entirely new twist to the developing science of political economy. Ricardo invented the concept of the “economic model,” a tightly knit logical apparatus consisting of a few strategic variables, an apparatus that was capable of yielding, after a bit of manipulation, results of enormous practical import. At the heart of the Ricardian system is the notion that economic growth must sooner or later be arrested, owing to the rising cost of growing food on a limited land area. An essential ingredient of this argument is the Malthusian principle—enunciated in Thomas Malthus' *Essay on Population* (1798)—that population tends to increase up to the limits set by the existing supply of food, thus holding down wages. As the labour force increases, extra food to feed the extra mouths can be produced only by extending cultivation to less fertile soil or by applying capital and labour to land already under cultivation (with diminishing results because of the so-called law of diminishing returns). Although wages are held down, profits do not rise proportionately because tenant farmers outbid each other for superior land. The chief beneficiaries of economic progress, therefore, are the landowners.

Since the root of the trouble, according to Ricardo, is the declining yield of wheat per unit of land, one obvious solution is to import cheap wheat from other countries. Eager to show that Britain would benefit from specializing in manufactured goods and exporting them in return for food, Ricardo hit upon the “law of comparative costs” as proof. He assumed that, within countries, labour and capital are free to move in search of the highest returns; between countries, however, they are not. In these circumstances, Ricardo showed, the benefits of trade are determined by a comparison of costs *within* each country, rather than by a comparison of costs *between* countries. It pays a country to specialize in the production of those goods that it can produce *relatively* more efficiently and to import everything else; although India may be able to produce everything more efficiently than England, India is nevertheless well advised to concentrate its resources on textiles, in which its efficiency is relatively greater, and to import British capital goods. The beauty of the argument is that if all countries take full advantage of the territorial division of labour, total world output is certain to be larger than it will be if some or all countries try to become self-sufficient. Ricardo's law became the fountainhead of 19th-century free-trade doctrine, which would have been enough, if he had said nothing else, to give him a place in the economists' pantheon.

The influence of Ricardo's treatise was felt almost as soon as it was published, and for over half a century the Ricardian system dominated economic thinking in Britain. In 1848 John Stuart Mill's restatement of Ricardo's thought in his *Principles of Political Economy* brought it new authority. After 1870, however, most economists turned their backs on the range of problems that had concerned Ricardo and began to re-examine the foundations of the theory of value; that is, they became interested in the theory of why goods exchange at particular prices, so that for a while they devoted almost all of their efforts to the problem of resource allocation under conditions of perfect competition.

Marxism

A few words must first be said, however, about the last of the classical economists, Karl Marx. The first volume of *Das Kapital* appeared in 1867; the second and third after his death, in 1885 and 1894. For a generation, therefore, the competitive market theorists jostled with the followers of Marx. By 1900 the intellectual battle was over, and thereafter professional economists largely lost interest in Marx. Despite the Russian Revolution, despite what amounts to official endorsement of Marxism in one-third of the world, and despite the lingering influence of Marx's ideas, Marxian economics has been moribund ever since Marx's death in 1883. If Marx may be called "the last of the classical economists," it is because to a large extent he found his economics not in the real world but in the teachings of Smith and Ricardo. They had espoused a "labour theory of value," which holds that products exchange roughly in proportion to the labour costs incurred in producing them. Marx worked out all the logical implications of this theory and added to it "the theory of surplus value," which rests on the axiom that human labour alone creates all value and hence constitutes the sole source of profits. It is an axiom in the sense that it cannot be established in terms of the theory itself: it must be imported from without. To say that an economist is a Marxian economist is in effect to say that he shares the value judgment that it is socially undesirable for some people in the community to derive their income merely from the ownership of property. Since few professional economists in the 19th century accepted this ethical postulate and most were indeed inclined to find some social justification for the existence of private property and the income derived from it, Marxian economics fell on deaf ears. The Marxian system, moreover, culminated in three great generalizations: the tendency of the rate of profit to fall, the growing impoverishment of the working class, and the increasing severity of business cycles, of which the first is the linchpin of all the others. Marx's exposition of the "law of the declining rate of profit" is invalid; with it all of Marx's other predictions fall to the ground. In addition, Marxian economics had little to say on some of the practical problems that are the bread and butter of economists in any society. This is enough to suggest why Marxian economics failed to make many converts among academic economists. Marxists will reply that the reason is simply that academic economists have always been “lackeys of the capitalist class.” Perhaps so, but the fact remains that Marx has had virtually no effect on modern economic thought.

The marginalists

The marginal revolution was essentially the work of three men: Stanley Jevons, an Englishman; Carl Menger, an Austrian; and Léon Walras, a Frenchman. Their contribution was the replacement of the labour theory of value by the marginal utility theory of value; their explanation of prices began with the behaviour of consumers in choosing among increments of goods and services (see utility and value). The idea of emphasizing the marginal or last unit proved in the long run to be more significant than the introduction of utility. It was the consistent application of marginalism that marks the true dividing line between classical theory and modern economics. The classical political economists saw the economic problem as that of predicting the effects of changes in the quantity of capital and labour on the rate of growth of national output. The marginal approach, however, focussed on the conditions under which these factors tend to be allocated with optimal results among competing uses—optimal in the sense of maximizing consumers' satisfactions.

Throughout the last three decades of the 19th century, the English, Austrian, and French contributors to the marginal revolution largely went their own way. The Austrian school dwelt on the importance of utility as the determinant of value and vehemently attacked the classical economists as completely outmoded. A brilliant second-generation Austrian economist, Eugen von Böhm-Bawerk, applied the new ideas to the determination of the rate of interest, putting his stamp for all time on capital theory. The English school, led by Alfred Marshall, sought a reconciliation with the doctrines of the classical writers. The classical authors, Marshall argued, concentrated their efforts on the supply side in the market; marginal utility theory was concerned with the demand side, but prices are determined by both supply and demand, just as a pair of scissors cuts with both blades. Marshall, seeking to be practical, applied his “partial equilibrium analysis” to particular markets and industries.

The leading French marginalist was Léon Walras, who carried the approach furthest by describing the economic system in general mathematical terms. For each product there is a “demand function” that expresses the quantities of the product that consumers demand as depending on its price, the prices of other related goods, the consumers' incomes, and their tastes. For each product there is also a “supply function” that expresses the quantities producers will supply as depending on their costs of production, the prices of productive services, and the level of technical knowledge. In the market, for each product there is a point of “equilibrium”—

analogous to the equilibrium of forces in classical mechanics—at which a single price will satisfy both consumers and producers. It is not difficult to analyze the conditions under which equilibrium is possible for a single product. But equilibrium in one market depends on what happens in other markets (a "market" in this sense being not a place or location but a complex of transactions involving a single good), and this is true of every market. There are literally millions of markets in a modern economy, and therefore "general equilibrium" involves the simultaneous determination of partial equilibria in all markets. Walras' efforts to describe the economy in this way led the historian of economic thought Joseph Schumpeter to call his work "the Magna Carta of economics." Walrasian economics is undeniably abstract, but it provides an analytical framework for incorporating all of the elements of a complete theory of the economic system. It is not too much to say that nearly the whole of modern economics is Walrasian economics. Certainly, modern theories of money, of employment, of international trade, and of economic growth are all Walrasian general equilibrium theories in a simplified form.

The years between the publication of Marshall's *Principles of Economics* (1890) and the Great Crash in 1929 may be described as years of reconciliation, consolidation, and refinement. The three national schools gradually coalesced into a single mainstream. The theory of utility was reduced to an axiomatic system that could be applied to the analysis of consumer behaviour under various circumstances, such as a change in income or price. The concept of marginalism in consumption led eventually to the idea of marginal productivity in production, and with it came a new theory of distribution in which wages, profits, interest, and rent were all shown to depend on the "marginal value product" of a factor. Marshall's concept of "external economies and diseconomies" was developed by his leading pupil, Arthur Pigou, into a far-reaching distinction between private costs and social costs, thus laying the basis of welfare theory as a separate branch of economic inquiry. There was a gradual development of monetary theory, which explains how the level of all prices is determined as distinct from the determination of individual prices, notably by the Swedish economist Knut Wicksell. In the 1930s the growing harmony and unity of economics was rudely shattered, first by the simultaneous publication of Edward Chamberlin's *Theory of Monopolistic Competition* and Joan Robinson's *Economics of Imperfect Competition* in 1933 and then by the appearance of John Maynard Keynes's *General Theory of Employment, Interest and Money* in 1936.

The critics

Before going on, it is necessary to take note of the rise and fall of the German Historical school and the American Institutionalist school, which levelled a steady barrage of critical attacks on the orthodox mainstream. The German historical economists, who had many different views, basically rejected the idea of an abstract economics with its supposedly universal laws; they urged the necessity of studying concrete facts in national contexts. While they gave impetus to the study of economic history, they failed to persuade their colleagues that their method was invariably superior. The institutionalists are more difficult to categorize. “Institutional economics,” as the term is narrowly understood, refers to a movement in American economic thought associated with such names as Thorstein Veblen, Wesley Clair Mitchell, and John R. Commons. These writers had little in common aside from their dissatisfaction with the abstract theorizing of orthodox economics, its tendency to cut itself off from the other social sciences, and its preoccupation with the automatic market mechanism. They failed to develop a theoretical apparatus that would replace or supplement the orthodox theory. This may explain why the phrase “institutional economics” has become little more than a synonym for “descriptive economics.” The hope that institutional economics would furnish a new interdisciplinary social science proved stillborn. (This is perhaps not surprising, because it was by abstracting purely economic forces from the totality of social interactions that economics got so far ahead of the other social sciences in theoretical rigour.) Although there is no longer an institutionalist movement in economics, the spirit of institutionalism is alive in such works as the Harvard economist John Kenneth Galbraith's *The Affluent Society* (2nd ed., 1969) and *The New Industrial State* (1967).

Returning to the innovations of the 1930s, the theory of monopolistic or imperfect competition remains somewhat controversial to this day. The older economists had devoted all their attention to two extreme types of market structure, that of “pure monopoly,” in which a single seller controlled the entire market for one product, and that of “pure competition,” characterized by many sellers, highly informed buyers, and a single, standard product. The theory of monopolistic competition gave recognition to the range of market structures that lie between these extremes, including (1) markets having many sellers with “differentiated products,” employing brand names, guarantees, and special packaging that cause consumers to regard the product of each seller as unique; (2) “oligopoly,” markets dominated by a few large firms; and (3) “monopsony,” markets with a single monopolistic buyer and many sellers. The theory produced the powerful conclusion that competitive industries in which each seller has a partial monopoly because of product differentiation will tend to have an excessive number of firms, all charging a higher price than they would if the industry were perfectly competitive. Since product differentiation—and the associated phenomenon of advertising—seems to be characteristic of most industries in developed capitalist economies, the new theory was immediately hailed as injecting a healthy dose of realism into orthodox price theory. Unfortunately, its scope was not great enough. It failed to provide a satisfactory theory of price determination under conditions of oligopoly. In advanced economies many of the manufacturing industries are oligopolistic. The result has been to leave a somewhat undigested lump at the centre of modern price theory, a constant reminder of the fact that economists still lack an adequate explanation of the conditions under which the giant firms of rich countries conduct their affairs.

Keynesian economics

The second major breakthrough of the 1930s, the theory of income determination, was primarily the work of one man—John Maynard Keynes. Keynes asked questions that in some sense had never been asked before; he was interested in the level of national income and the volume of employment rather than in the equilibrium of the firm or the allocation of resources. It was still a problem of demand and supply, but “demand” here means the total level of effective demand in the economy, and “supply” means the nation's capacity to produce. When effective demand falls short of productive capacity, the result is unemployment and depression; when it exceeds the capacity to produce, the result is inflation. The heart of Keynesian economics consists of an analysis of the determinants of effective demand. If one ignores foreign trade, effective demand consists essentially of three spending streams: consumption expenditures, investment expenditures, and government expenditures, each of which is independently determined. Keynes attempted to show that the level of effective demand so determined may well exceed or fall short of the physical capacity to produce goods and services: that there is no automatic tendency to produce at a level that results in the full employment of all available men and machines. This fundamental implication of the theory came as something of a shock to exponents of the traditional economics who had been inclined to take refuge in the assumption that economic systems tend automatically to full employment. By keeping his attention focussed on macroeconomic aggregates, like total consumption and total investment, and by a deliberate simplification of the relations between these economic variables, Keynes achieved a powerful model that could be applied to a wide range of practical problems. His system subsequently underwent considerable refinement—some have said that Keynes himself would hardly have recognized it—and became thoroughly assimilated into the body of received doctrine (see economic stabilizer). Still, it is not too much to say that Keynes is perhaps the only economist to have added something really new to economics since Walras and perhaps since Ricardo.

Keynesian economics as conceived by Keynes was entirely “static”;

that is, it did not involve time as an important variable. But a disciple of Keynes, Roy Harrod, soon developed a simple macroeconomic model of a growing economy; in 1948 he published *Towards a Dynamic Economics*, launching an entirely new speciality, "growth theory," which absorbed the attention of an increasing number of economists.

Postwar developments

In the 25-year period following World War II, economics was so totally transformed that those who studied it before the war might as well have lived in another world. First of all, there was an enormous increase in the use of mathematics, which came to permeate virtually every branch of economics. Previously, few economists had made use of mathematics other than differential and integral calculus. Matrix algebra became important with the advent of "input–output analysis," an empirical method of reducing the technical relations between industries to a manageable system of simultaneous equations; it was an attempt to put quantitative flesh on the bones of a general equilibrium model of the economy. A closely related phenomenon was the development of "linear programming" and "activity analysis," which opened up a whole host of industrial problems to numerical solution and introduced economists for the first time to the mathematics of "inequalities" rather than exact equations. Likewise, the emergence of "growth economics" promoted the use of difference and differential equations.

Hand in hand with the spread of mathematical economics went an increasing sophistication of empirical work under the rubric of "econometrics," comprising a combination of economic theory, mathematical model building, and statistical testing of economic predictions. The development of econometrics had an impact on economics in general, since those who formulated new theories began to cast them in terms that allowed them to be empirically tested.

The postwar years also saw a renewal of interest in the underdeveloped countries. Economists became aware that they had too long neglected "an inquiry into the causes of the wealth of nations." There was also a conviction that economic planning of one variety or another was needed to close the gap between the rich and poor countries. Out of these concerns came the field of development economics. Regional economics, urban economics, health economics, and the economics of education are other offshoots of the mainstream since 1945.

The postwar tendencies in economic thought were best exemplified, not by the emergence of new techniques or by the addition of new parts to the economics curriculum but by the disappearance of divisive “schools,” by the increasingly standardized professional training of economists all over the world, and by the transformation of the science from a rarefied academic exercise to an operational discipline geared to practical advice. This transformation brought prestige to the profession but also a new responsibility: now that economics really mattered, economics had to reckon with the conflict that so often exists between analytical precision and economic relevance.

The question of relevance was at the centre of a “radical critique” of economics that developed along with the campus revolts of the late 1960s. The radical critics declared that economics had become a defense of the status quo and that its practitioners had joined the power elite. The marginal techniques of the economists, ran the argument, were profoundly conservative in their bias, and encouraged a piecemeal rather than a revolutionary approach to social problems; likewise, the tendency in theoretical work to ignore the everyday context of economic activity amounted in practice to the tacit acceptance of prevailing institutions. The critics said that economics should abandon its claim of being a value-free social science and address itself to the great questions of the day—those of civil rights, poverty, imperialism, and nuclear war—even at the cost of analytical rigour and theoretical elegance.

It is true that the study of economics encourages a belief in reform rather than revolution; economics as a science does not provide enough certitude for any thoroughgoing reconstruction of the social order. It is also true that most economists tend to be deeply suspicious of monopoly in all forms, including state monopolies, and to favour competition between independent producers as a way of diffusing economic power. Finally, most economists prefer to be silent on large questions if they have nothing to offer beyond the expression of personal preferences: most economists as economists are fundamentally concerned with the professional standards of their discipline, and this may mean in some cases frankly conceding that economics has as yet nothing very interesting to say about these questions. (It does not mean, however, that they desire to justify the status quo.) Yet the radical critique of modern economics was not to be lightly dismissed. The radical economists were posing issues that were important. At the very least it could do the economic researcher no harm to think about the social and political relevance of his work.

Methodological considerations in contemporary economics

Economists are sometimes confronted with the charge that their discipline is not a science. Human behaviour, it is said, cannot be analyzed with the same objectivity as the behaviour of atoms and molecules. Value judgments, philosophical preconceptions, and ideological biases must interfere with the attempt to derive conclusions that are independent of the particular economist espousing them. Moreover, there is no laboratory in which economists can test their hypotheses.

This argument raises issues for all of the social sciences. Only a very general reply can be given here. Economists are wont to distinguish between “positive economics” and “normative economics.” Positive economics seeks to establish facts: Will a subsidy to butter producers lower the price of butter? Will a rise in wages in the automobile industry reduce the employment of automobile workers? Will devaluation improve the balance of payments? Does monopoly foster technical progress? Normative economics, on the other hand, is not concerned with matters of fact but with questions of policy, of “good” or “bad”: Should the goal of price stability be sacrificed to that of full employment? Should income be taxed at a progressive rate? Should there be legislation in favour of competition?

Positive economics in principle involves no judgments of value; its findings may be as impersonal as those of astronomy and meteorology, two natural sciences that are also denied the advantage of conducting laboratory experiments. As the British philosopher David Hume argued 200 years ago, there is no logical way to deduce “ought” from “is” or prescriptions from descriptions; all statements of fact are ethically neutral. In that sense a value-free economics is possible (at least in principle): if economics is about the application of means to achieve given ends, there would seem to be no reason why one cannot analyze the allocation of means to achieve *any* end. This is not to deny that most of the interesting economic propositions involve the addition of definite value judgments to a body of established facts, that ideological bias creeps into the very selection of the questions that economists investigate, that what is a means from one point of view may be an end from another, nor even that much practical economic advice is loaded with concealed value judgments, the better to persuade rather than merely to advise. This is only to say that economists are human. The commitment of economists the world over to the ideal of value-free positive economics (or to the candid declaration of personal values in normative economics) serves as a defense against the attempts of special interests to bend the science to their own purposes. The best assurance against bias on the part of any particular economist is the criticism of other economists. The best protection against special pleading in the name of science is the professional standards of scientists.

Methods of inference

But how, one may ask, are facts established in a science that cannot conduct experiments? In essence, the answer is: by means of statistical inference. Economists typically begin by describing the area under study according to what they feel to be important. Then they construct a “model” of the real world, deliberately repressing some of its features and emphasizing others; they abstract, isolate, and simplify, thus imposing order on a world that at first glance appeared disorderly. Having evolved an admittedly unrealistic representation of the real world, they then manipulate the model by a process of logical deduction, arriving eventually at some prediction or implication that is of general significance. At this point, they return to the real world to see whether or not the prediction is borne out by observed events.

But the observable events that are available to test a theory never exhaust the population of all such events: they are merely a sample of it. This raises the problem of statistical inference; namely, what can be inferred about a population from a sample of the population? The theory of statistical inference is simply an agreed-upon procedure for making such inferences, but in the nature of the case it never succeeds in removing all elements of judgment from an inference. Thus the empirical truths of economics are invariably surrounded by a band of doubt, and economists speak of them as “probable” or “likely”; they are propositions in which economists have “a certain degree of confidence” because it is unlikely that they could have come about by chance.

It follows that judgments are at the heart of both positive and normative economics. It is easy to see, however, that judgments about “degrees of confidence” and “statistical levels of significance” are of a totally different order from those that crop up in normative economics. When men say that every individual should be allowed to spend his income as he likes, that people should not be free to control material resources and to employ others, or that governments must offer relief for the victims of inexorable economic forces, they are making the kind of value judgments that laymen have in mind when they accuse economists of producing personal preferences in the guise of scientific conclusions. There is no room for such value judgments in positive economics.

Testing theories

In the past some economists tended to claim too much for their propositions. Economic models were said to be based on fundamental axioms and premises about economic behaviour that were absolutely true a priori because they were derived from an examination of one's own economic behaviour. Since the theorems of the model were deduced from these axioms by the laws of logic, the theorems also were held to be true a priori. Economic models did not need to be confronted with empirical evidence.

This extreme apriorist position may be contrasted with the ultraempiricist view, which holds that one must begin and end with observable facts; the latter approach, however, has never appealed to more than a small minority of economists. In the middle ground between these two sharply opposing views is the methodological position that has found increasing acceptance among modern economists. It argues that one must test the predictions or conclusions of a model but without worrying too much about the realism of its premises, axioms, or assumptions. Most assumptions in economic theory cannot be tested directly. For example, there is the famous assumption of price theory that businessmen strive to maximize profits. Attempts to find out whether they do, by asking them, usually fail; after all, businessmen are no more fully conscious of their own motives than other people are. A logical approach would be to observe businessmen in action. But that would require knowing what sort of action is associated with profit maximizing, which is to say that one would have drawn out all the implications of a profit maximizing model. Thus one would be testing an assumption about business behaviour by comparing the predictions of a theory of the firm with observations from the real world.

This is not as easy as it sounds. Since the predictions of economics partake of the nature of probability statements, there can be no such thing as a conclusive, once-and-for-all test of an economic hypothesis. The science of statistics cannot prove any hypothesis, it can only fail to disprove it. A theory that survives a statistical test is not true as such; it is only provisionally true because it has so far resisted all attempts to falsify it. Attempts to falsify economic hypotheses never yield unambiguous results, and hence economic theories tend to survive until they are falsified repeatedly with new or better data. This is not because they are *economic* theories but because the attempt to compare predictions with outcomes in the social sciences is always limited by the rules of statistical inference.

It is not remarkable that competing theories exist to explain the same phenomena, with economists disagreeing as to which theory is to be preferred. While virtually all economists today agree that theories should be submitted to empirical testing and that the theory is to be preferred that allows predictions that conform, in a probabilistic sense, most closely to observable events, this precept can be very difficult to apply in practice. There have been periods in the history of economics when there was overwhelming agreement in the profession as to which models or theories were “true.” But a period of consensus may be followed by a generation of doubt until a new departure is made that succeeds in producing a new consensus. In this, economics is not very different from physics.

Much has been written about the doubtful accuracy of economists' predictions. Of course, economists cannot foretell the future as such; only soothsayers do that. Economists can foretell the effects of specific changes in the economy, but they are better at predicting the direction than the actual magnitude of events. When economists predict that a tax cut will raise national income, one may be confident that the prediction is accurate; when they predict that it will raise national income by a certain amount in three years, however, the forecast is likely to miss the mark. The reason is that most economic models do not contain any explicit reference to the passage of time and hence have little to say about how long it takes for a certain effect to make itself felt. Short-period predictions generally fare better than long-period ones, in part because most economic models rely on propositions about the plans and intentions of economic agents, whereas the data on which the theories are tested are derived from past events. This is disappointing, but it does not mean that economics is not a science.

Microeconomics

Since Keynes, economic theory has been of two kinds: macroeconomics—or the study of the determinants of national income—and the traditional microeconomics. The latter approaches the economy as if it were made up only of business firms and households (ignoring governments, banks, charities, trade unions, and all other economic institutions) interacting in two kinds of markets—product markets and markets for productive services, or factor markets. Households appear as buyers in product markets and as sellers in factor markets, where they offer men, machines, and land for sale or hire. Firms appear as sellers in product markets and as buyers in factor markets. In each type of market, price is determined by the interaction of demand and supply, and the problem of microeconomic theory is to say something meaningful about the forces that make up demand and supply.

Theory of choice

At first it appears that all one can say is that everything depends on everything else. But firms and households do not behave in a vacuum. Firms face certain technical constraints in producing goods and services, and households have definite preferences for some products over others. It is possible to express the technical constraints facing business firms by writing down a series of "production functions," one for each firm. A production function is simply a kind of equation that expresses the fact that the output of a firm depends on the quantity of inputs it employs and, in particular, that inputs can be technically combined in different proportions to produce a given level of output. A production engineer could calculate, on the basis of existing technical knowledge, the largest possible output that could be produced with every possible combination of inputs and in this way could define a boundary to the range of production possibilities open to a firm. By itself this does not tell how much the firm will produce or what mixture of products it will make or what combination of inputs it will adopt: these depend on the prices of products and the prices of inputs (or “factors of production”), which have yet to be determined. One may assume that the firm is motivated in a particular way: it wants to maximize profits, which are defined as the difference between the sales value of its output and the money outlays required to obtain its inputs. It will, therefore, select that combination of inputs that minimizes the costs of producing any given quantity of output and will select from the range of possible combinations of products that combination that maximizes its revenues. This is to say that it always tries to move along its production function, along the edge of the boundary of technical possibilities. But where it ends depends, in part, on the demand for its products. This leads to the part played by households in the system.

Households are endowed with definite “tastes” that can be expressed in a series of “utility functions,” one for each household. A utility function is an equation like a production function, expressing the fact that the pleasure or satisfaction that households derive from consumption depends on the products that they purchase and on the various ways in which they combine these products in consumption to yield a given level of satisfaction. The utility function need not be specified in the same detail as a production function. One may think of it as a general description of the household's preferences between all the paired alternatives with which it will be confronted. Here, too, it is necessary to assume something about motivation to make any progress: the assumption is that households seek to maximize satisfaction, distributing their given incomes among available consumer goods in such a way as to derive the largest possible “utility” from consumption. Their incomes, however, remain to be determined.

The purpose of production functions in economic theory is to provide an anchor in the bedrock of technology from which to derive the “supply curves” of firms in product markets and the “demand curves” of firms in factor markets. Similarly, the purpose of utility functions is to provide an anchor in subjective “tastes” from which to derive the “demand curves” of households in product markets and the “supply curves” of households in factor markets. All of these demand and supply curves express the quantities demanded and supplied as a function of prices, not because price is the only determinant of economic behaviour but because the purpose is to have a theory of price determination. Much of economic theory is devoted to showing how various production and utility functions, coupled with certain assumptions about behaviour, lead to demand and supply curves in which the quantity demanded is inversely related and the quantity supplied positively related to price. The figure depicts these relationships (curves would be just as suitable as straight lines).

Not all demand and supply curves look alike. The essential point is that most demand curves are negatively inclined, while most supply curves are positively inclined. This may seem a modest result for a great deal of effort, but the argument has powerful implications. The participants in a market will be driven automatically to the price at which the two curves intersect; this price p is called the “equilibrium” price or “market-clearing” price because it is the only price at which supply and demand are equal. If it is a market for butter, any change in the production function of dairy farmers or in the utility function of butter consumers or in the prices of cows, grassland, and milking equipment or in the incomes of butter consumers or in the prices of nondairy products that consumers buy can be shown to lead to definite changes in the equilibrium prices of butter and in the equilibrium quantity of butter produced. Better still, the effects of a government ceiling on the price of butter or of a tax on butter producers or of a price-support program for dairy farmers can be predicted with almost perfect certainty. As a rule, the prediction will refer only to the direction of change (the price will go up or down); but if the demand and supply curves of butter can be defined in quantitative terms on the basis of past data, one may be able to predict the actual magnitude of the change.

Theory of allocation

This analysis of the behaviour of firms and households is to some extent symmetrical: all economic agents are conceived of as ordering a series of attainable positions in terms of an entity they are trying to maximize. For a firm these attainable positions are essentially input combinations; for a household they are product combinations. From the maximizing point of view, some combinations are better than others; the best combination is called the “optimal” or “efficient” combination. The rule for efficient, optimum allocation may now be stated baldly: an optimum allocation is one that equalizes the returns of the marginal or last unit to be transferred between all the possible uses. In the theory of the firm, an optimum allocation of outlays among the factors of production implies that the “marginal physical product” of an additional dollar devoted to hiring the services of any one of the factors is the same for all factors; the so-called law of eventually diminishing marginal productivity, a property of a wide range of production functions, ensures that such an optimum exists. In the theory of consumer behaviour an optimum situation obtains when the consumer has distributed his given income in such a way that the “marginal utility” of each additional dollar spent on any of the products purchased is equal for all products; the “law of eventually diminishing marginal utility,” a property of a wide range of utility functions, ensures that such an optimum exists. These are merely particular examples of the “equimarginal principle,” which is not only at the core of the theory of the firm and the theory of consumer behaviour but also underlies the theory of money, of capital, and of international trade. In fact, the whole of microeconomics is nothing more than the spelling out of this principle in ever wider contexts.

The equimarginal principle is, of course, applicable to any decision that involves alternative courses of action. Economics furnishes a technique for thinking about decisions, whatever their character and whosoever makes them. Military planners may, for example, consider a variety of weapons in the light of a single objective, that of damaging an enemy; some of the weapons are effective against the enemy's army, some against the enemy's navy, and some against his air force; the problem is to find an optimal allocation of the defense budget, one that equalizes the marginal contribution of each type of weapon. But defense departments rarely have single objectives; along with maximizing damage to an enemy there may be another objective, such as minimizing losses from attacks. In that case, more than the equimarginal principle is needed for a decision; it is necessary to know how the department ranks the two objectives in order of importance, since different rankings will imply different optima. But a ranking of objectives is simply a utility function or a preference function.

In other words, when an institution pursues multiple ends, decisions about how to achieve them require a weighting of the ends. Every decision involves a “production function”—a statement of what is technically feasible—and a “utility function”; the equimarginal principle is then invoked to provide an efficient, optimal strategy. This applies just as well to the running of hospitals, churches, and schools as to the conduct of a business enterprise, to the location of an international airport as well as to the design of a development plan for an underdeveloped country. This is why economists crop up in what seem to be the most unlikely places, advising on activities that are obviously not being conducted for economic reasons.

Macroeconomics

There is, however, an approach to economics in which the foregoing considerations do not apply. That is the field known as macroeconomics. In macroeconomics one is concerned with the aggregate outcome of individual actions. Keynes's “consumption function,” for example, which relates aggregate consumption to national income, is not built up from individual consumer behaviour;

it is simply an empirical generalization. The focus is on income and expenditure flows rather than on markets. Purchasing power flows through the system from business investment to consumption, but it leaks out at two places in the form of personal and business savings. Counterbalancing the savings are investment expenditures in the form of new capital goods, houses, and so forth, which constitute a source of new injections of purchasing power in every period. Since savings and investments are carried out by different people for different motives, there is no reason why “leakages” and “injections” should be equal in every period. If they are not equal, national income, the sum of all income payments to the factors of production, will rise or fall in the next period. When planned savings equal planned investment, income will be at an equilibrium level, that is, a level at which it can sustain itself; when the plans of savers do not match those of investors, the level of income will go on changing until the two do match. One can complicate this simple model by making investment a function of the interest rate; by introducing the government budget, the money market, labour markets, imports and exports, foreign investment; and so forth. But all this is far removed from the problem of resource allocation and from the maximizing behaviour of individual economic agents.

The result is a kind of intellectual schizophrenia in which the techniques of microeconomics do not carry over fully into macroeconomics and vice versa. This is widely held to be an unsatisfactory state of affairs; economists have in recent years sought to build a bridge between the individual consumer and the overall consumption function and between the individual investor and the behaviour of aggregate investment. Nevertheless, the bridge remains incomplete, and the student of economics must be prepared to work with two boxes of tools.

Fields of contemporary economics

The following is a bird's-eye view of the main fields of contemporary economics.

Public finance

Since the time of Ricardo economists have been concerned with the incidence of taxes, that is, with determining who it is that really pays a tax. If a corporation faced with a profits tax reacts by raising its prices, it may succeed in making the consumer pay the tax; on the other hand, if sales decline as a result of the rise in price the firm may have to lay off some of its workers, and the burden of the tax will be shared by consumers, wage earners, and shareholders. This simple example shows how complex may be the actual incidence of a tax. A large part of the literature of public finance in the 19th century was devoted to such problems.

Keynesian economics brought new dimensions to public finance: the older preoccupation with tax incidence gave way to the analysis of the impact of government expenditures on the level of income and employment. It was some time, however, before economists realized that they lacked a theory of government expenditures, that is, a set of criteria for determining what activities should be supported by governments and what should be the relative expenditure on each. One of the most exciting recent developments in the field of public finance is the attempt to devise such criteria. Decisions on public expenditures have proved to be susceptible to much of the traditional analysis of microeconomics. In the 1960s there developed a technique known as “cost–benefit analysis,” which tries to appraise all of the economic costs and benefits, direct and indirect, of a particular activity so as to decide how to distribute a given public budget most effectively between different activities. This technique has been applied to everything from the construction of hydroelectric dams to the control of tuberculosis. Its exponents hope that the same type of analysis that has proved so fruitful in the past in analyzing individual choice may also succeed with problems of social choice.

Money

One of the oldest, widely accepted functions of government is control over the supply of money. The dramatic effects of changes in the quantity of money on the level of prices and the volume of economic activity were recognized and thoroughly analyzed in the 18th century, and monetary economics has ever since constituted one of the principal branches of economics. In the 19th century a complex and somewhat crudely formulated tradition grew up known as the “quantity theory of money,” which held that any change in the supply of money can only be absorbed by variations in the general level of prices (the purchasing power of money). In consequence, prices will tend to change proportionately with the quantity of money in circulation. As the growth of fiat paper money gave governments increasingly effective control over the stock of circulating media, the quantity theory of money supplied an apparently simple rationale for the management of the economy: all that was needed to prevent inflation or deflation was to vary the quantity of money in circulation inversely with the level of prices.

One of the targets of Keynes's attack on traditional thinking in his *General Theory of Employment, Interest and Money* was this quantity theory of money. Keynes produced a different theory of the demand for money that implied that the impact of a change in the stock of money on the level of national income is weak and at best indirect; the effect on prices is virtually nil, he maintained, at least in economies with heavy unemployment such as prevailed in the 1930s. He put his emphasis instead on government budgetary and tax policy and direct control of investment. As a consequence, economists lost faith in monetary management and came to regard monetary policy as more or less ineffective in controlling the volume of economic activity.

In the 1960s there was a remarkable revival of the older view, at least among a small but growing school of American monetary economists. They accepted much of Keynesian economics but argued that the effects of fiscal policy are unreliable unless the quantity of money is regulated at the same time. They refurbished the quantity theory of money and tested the new version on a variety of data for different countries and for different time periods, leading to the broad conclusion that the quantity of money does matter.

In the late 20th century the controversy was still raging. It is notable that this debate, unlike previous debates in the history of monetary economics, was characterized by disputes over empirical findings—that is, it was focussed on the testable character of different monetary theories rather than on the manner of their formulation. Progress was made slower by the political overtones of the controversy: in some countries, belief in the efficacy of monetary policy had become a kind of litmus test of political conservatism. Nevertheless, a reconciliation between Keynesians and quantity theorists needed only some agreement as to the magnitude of monetary forces and the degree of stability of the demand for money. Monetary economics seemed at last to be coming of age as an empirical discipline.

International economics

The foundations of international economics were firmly established in the 19th century. The subject has consisted ever since of two distinct but connected parts: (1) the "pure theory of international trade," which seeks to account for the gains obtained from trade and to explain how these gains are distributed among countries, and (2) the "theory of balance-of-payments adjustments," which analyzes the workings of the foreign exchange market, the effects of alterations in the exchange rate of a currency, and the relations between the balance of payments and the level of economic activity.

In modern times, the Ricardian pure theory of international trade has been reformulated by the American Paul Samuelson, improving on the earlier work of two Swedish economists, Eli Heckscher and Bertil Ohlin. The so-called Heckscher-Ohlin theory explains the pattern of international trade as determined by the relative land, labour, and capital endowments of countries: a country will tend to have a relative cost advantage in goods requiring the intensive use of the country's relatively abundant factor of production (thus land-rich

Canada exports wheat) and to import goods requiring the intensive use of the country's relatively scarce factor (thus capital-poor Canada imports American automobiles). This theory absorbs Ricardo's law of comparative costs but goes beyond it in linking the pattern of trade to the economic structure of trading nations. It implies that foreign trade is a substitute for international movements of labour and capital—which raises the intriguing question of whether or not foreign trade may work to equalize the prices of all factors of production in all trading countries. Whatever the answer, the Heckscher-Ohlin theory provides a model for analyzing the effects of a change in trade on the industrial structures of economies and, in particular, on the distribution of income between factors of production. Much of the recent effort of specialists in international economics has gone toward refining the Heckscher-Ohlin model and testing it on an ever wider range of empirical evidence.

Labour

Like monetary and international economics, labour economics is an old economic speciality. It gets its raison d'être from the peculiarities of labour as a commodity. Labour itself is not bought and sold; rather, its services are hired and rented out. But since people cannot be disassociated from their services, various nonmonetary considerations play a role in the sale of labour services as contrasted with the sale of machine time or the rental of land. Yet, the bulk of the literature in labour economics was until recently concerned solely with the demand side of the labour market. Wages, the textbooks all said, were determined by the "marginal productivity of labour," that is, by the relationships of production and by consumer demand. If the supply of labour came into the picture at all, it was merely to allow for the presence of trade unions; unions could only raise wages by limiting the supply of labour.

After a long period of neglect, the supply side of the labour market began, in the 20th century, to attract the attention of economists. First, attention shifted from the individual worker to the household as a supplier of labour services; the increasing tendency of married women to enter the labour force and the wide disparities and fluctuations observed in the rate that females participate in a labour force drew attention to the fact that an individual's decision to supply labour is not independent of the size, age structure, and asset holdings of the household to which he or she belongs. Second, the new concept of "human capital"—that people make capital investments in their children and in themselves by incurring the costs of education and training, the costs of searching for better job opportunities, and the costs of migration to other labour markets—has served as a unifying explanation of the diverse activities of households in labour markets. In this way, capital theory has become the dominant analytical tool of the labour economists, replacing or supplementing the traditional theory of consumer behaviour. The economics of training and education, the economics of information, the economics of migration, the economics of health, and the economics of poverty are some of the by-products of this new perspective. A field that was at one time regarded as rather cut-and-dried has taken on new vitality.

Labour economics, old or new, has always regarded the explanation of wages as its principal task, including the factors determining the general level of wages in an economy and the reasons for wage differentials between industries and occupations. Wages are influenced by trade unions; the impact of their activities is of increased importance at a time when most governments manage the economy with one eye on the unemployment statistics. The prewar fears of chronic unemployment gave way to the postwar fears of chronic inflation at or near levels of full employment. In response to this a vast literature sprang up after 1945 analyzing the inflationary pressures stemming from both the supply side and the demand side of labour markets. Whether prices were being pushed up by the labour unions ("cost push") or pulled up by excess purchasing power ("demand pull") became the issues in this long debate on inflation, a controversy that is, of course, intimately related to the quarrels in monetary economics mentioned earlier.

Industrial organization

The principal concerns of this field are the structure of markets, public policy toward monopoly, the regulation of public utilities, and, of late, the economics of technical change.

The monopoly problem, or, more precisely, the problem of the maintenance of competition, does not fit well into the received body of economic thought. Economics started out, after all, as the theory of competitive enterprise, and even today its most impressive theorems require the assumption of numerous small firms, each having a negligible influence on price. Yet the typical market structure of manufacturing today is that of oligopoly—competition among the few—and some industries are dominated by firms so large that their annual sales volume exceeds the national income of the smaller countries of western Europe. It is tempting to leap to the conclusion that oligopoly is deleterious to economic welfare, on the ground that it leads to the misallocation of resources. But some economists, notably Joseph Schumpeter, have argued that economic growth and technical progress are brought about not through free competition but through large firms and the destruction of competition. According to this view, monopoly has its origin in the need of business firms to protect themselves from the risks associated with the introduction of new products, new techniques, and new methods of marketing. The giants, therefore, compete not in price but in successful innovation, and this kind of competition has proved more effective for economic progress than the more traditional price competition described in orthodox textbooks of economic theory.

Although this thesis smacks of *post hoc ergo propter hoc* ("after this, therefore because of this")—giant firms have prospered in rapidly growing economies; therefore, growth is due to giant firms—it makes the merits of "trust busting" and cartel dissolution somewhat less compelling. The question is what sort of competition is socially most desirable. If each of four or five large firms in an oligopolistic industry finds it necessary to compete in terms of the quality of its products and its research or by means of better technology and superior merchandising, the performance of the industry may well be more satisfactory than if it were reorganized into a price-competitive industry. But if the four or five giants settle down to a quiet life and concentrate their rivalry on sales promotion techniques, the verdict must be less favourable. One cannot, it seems, draw facile conclusions about the competitive results of different market structures; it is necessary to approach the monopoly problem with a generous dose of pragmatism.

The reason why there is so much uncertainty in the economic discussion of policies toward big business is the lack of a general theory of oligopoly. There are dozens of special theories applying to special cases, but there is no single, organizing framework with testable implications about the behaviour of oligopolists in general.

Agriculture

Farming has long provided economists with their favourite example of a perfectly competitive industry. But with increasing government regulation of agriculture, it also provides striking examples of the effects of price controls, income supports, output ceilings, and marketing cartels. Agricultural economics commands attention wherever governments wish to stimulate farming or to protect farmers—which is to say, everywhere.

Agricultural economists generally have been closer to their subject matter than other economists. In consequence, more is known about the technology of agriculture, the nature of farming costs, and the demand for agricultural goods than is known about any other industry. The student of economics who wants to learn how to estimate a production function or a demand curve is well advised to go to the literature on agricultural economics.

The underdeveloped countries have furnished a new laboratory for agricultural economics. Many such countries have a "subsistence agriculture," in which the farmer produces mainly for his own family consumption and brings to market only what is left over. Subsistence farmers are only tenuously linked to the money economy. They are more reluctant than commercial farmers to take the risks entailed in experimenting with new seeds, fertilizers, and farming methods: given the vagaries of the weather, they prefer to operate on the basis of the worst weather that can be expected rather than the best or even the average. While the pessimism of subsistence farmers is perfectly rational, it makes the task of predicting their response to new prices or new methods doubly difficult. The economist must also recognize that every agricultural area presents its own production, processing, and marketing problems. To suggest changes that will raise agricultural productivity in these circumstances is no easy task, and agricultural economists often find themselves warning governments not to intervene too vigorously, since much intervention in the past has been shown to be wrong or inappropriate.

The problem of economic development in Africa, Asia, and Latin America centres on the agricultural sector; one of the abiding questions is how far industrialization can proceed without there first being an agricultural revolution. For this reason, if for no other, agricultural economics has a large future.

Growth and development

The study of economic growth and development is not a single branch of economics but falls, in fact, into two quite different fields. The two fields—"growth" and "development"—employ different methods of analysis and are indeed addressed to two distinct types of inquiry.

Development economics is easy to describe. It is one of the three major subfields of economics, the other two being microeconomics and macroeconomics. Development economics resembles economic history in that it seeks to explain the changes that take place in economic systems with the passage of time.

The subject of economic growth is not so easy to characterize. It is the most technically demanding field in the whole of modern economics, impossible to grasp for anyone who lacks differential calculus. Its focus is the properties of equilibrium paths, rather than equilibrium states. One makes a model of the economy and puts it into motion, requiring that the time paths described by the variables be self-sustaining in the sense that they continue to be related to each other in certain characteristic ways. Then one can investigate the way economics might approach and reach these steady-state growth paths from given starting points. Beautiful and frequently surprising theorems have emerged from this experience, but as yet there are no really testable implications nor even definite insights into how economies grow.

Growth theory began with the work of Roy Harrod in England and Evsey Domar in the United States. Their joint product has been known ever since as the Harrod–Domar model. Keynes had shown that new investment has a multiplicative effect on income and that the increased income generates extra savings to match the extra investment, without which the higher income level could not be sustained. One may think of this as being repeated from period to period, remembering that investment, apart from raising income disproportionately, also generates the capacity to produce more output that cannot be sold unless there is more demand, that is, more consumption and more investment. That is all there is to the model. It contains one behavioral condition—that people tend to save a certain proportion of extra income, a tendency that can be measured. It contains one technical condition—that investment generates additional output, a fact that can be established. And it contains one equilibrium condition—that planned saving must equal planned investment in every period if the income level of the period is to be sustained. Given these three conditions, the model generates a time path of income and even indicates what will happen if income falls off the path.

More complex models have since been built, incorporating different saving ratios for different groups in the population, technical conditions for each industry, definite assumptions about the character of technical progress in the economy, monetary and financial equations, and much more.

Mathematical economics

Differential calculus has long been the traditional tool of mathematical economics. Many economic problems, particularly in microeconomics, take the form of maximizing some variable (such as profits) subject to a constraint (such as the production function), for which calculus supplies the simplest technique. Traditionally it was applied to problems in comparative statics. These problems include so-called endogenous variables, the values of which are determined within the model, as well as constants that originate outside the model and are called “exogenous variables” or “parameters.” The object is to discover the effects of changes in one or more of the parameters upon the equilibrium situation. The latter is a situation in which all of the endogenous variables are simultaneously in a state of rest. If the value of some of the parameters is changed, the result is a new equilibrium state.

Much economic analysis, even when it is expressed in words, is simply the method of comparative statics. But comparative statics has its limitations: it tells the investigator *where* the system will arrive, but it does not tell him *when* it will arrive or what will happen along the way; and it cannot tell him whether, once driven out of the way, it will ever get back to its destination. In other words, comparative statics ignores the process of adjustment from the old equilibrium state to the new one, and it entirely neglects the time element in that adjustment process. The study of this process of adjustment over time is called "economic dynamics," and one may think of it as the economics of disequilibria.

Just as differential calculus is the mathematics of comparative statics, difference and differential equations are the ideal tools for handling dynamic problems. Difference equations deal with time as a discrete variable—changing only from period to period—whereas differential equations treat time as a continuous variable; the choice between them is simply one of convenience. They enable one to ask such questions as: if the system is pushed out of equilibrium, perhaps because one of the parameters of the model has changed, will economic forces drive it toward a new equilibrium position or away from one, will the time path described by the endogenous variables be steady or fluctuating, and if fluctuating, will the movements be damped down or will they increase and become explosive?

Economic dynamics is one of the newer developments of mathematical economics, and often it falls short of the ambitious demands made on it. Dynamic models, for example, are typically formulated in terms of linear equations, not because the world is linear but because nonlinear equations can be very difficult to solve. Likewise, the coefficients of difference and differential equations are usually taken to be constants, again for the sake of making the mathematics of the analysis manageable. This means that if the economic environment changes as the model runs its course, its predictions will be false. An abiding danger in all mathematical economics is the tendency to adopt economic assumptions for the sake of mathematical convenience. The way to meet this danger is for economists to acquire enough mathematical sophistication so that they will not be dazzled by displays of mathematical technique.

Econometrics

Like mathematical economics, econometrics is something economists do rather than a special area of interest. Econometrics refers to the study of empirical data by statistical methods, the purpose of which is the testing of hypotheses and the estimation of relationships suggested by economic theory. Whereas mathematical economics considers the purely theoretical aspects of economic analysis, econometrics attempts to falsify theories that are expressed in explicit mathematical terms. But frequently the two go together.

The classic technique for estimating an economic relationship is that of “least squares,” which is a method of fitting a trend line to a scatter of observations that minimizes the square of the deviations of the observed points from the line. To take a simple example: the Keynesian theory assumes that consumers' expenditures depend principally on income; one may interpret this to mean that consumption depends *only* on income and then test the hypothesis by trying to fit a trend line to a series of observations of income and consumption over a period of time. In so doing, one is really saying that the observations that fall to either side of the line are due either to errors in measuring the variables or to errors in specifying the relationship between consumption and income. It is essential to the method of least squares that these “errors” be randomly distributed or at any rate distributed in known ways. When this condition is violated, least squares estimates are unreliable. It is sometimes difficult to tell with economic data just how the errors are randomly distributed, and it is precisely for this reason that an econometrician is needed rather than an ordinary statistician.

A still more significant trend in recent econometrics is the tendency to move from single-equation estimates (such as the relationship between consumption and income) to systems of simultaneous equations. While consumption depends on income, income also depends on consumption; this kind of interdependence requires two equations rather than one. More generally, most economic variables are the result of demand and supply forces that simultaneously determine quantities and prices. To estimate a demand curve for butter from a single-equation regression (by relating the price of butter to the quantities of butter consumed, the incomes of consumers, and the prices of near substitutes for butter) is likely to produce a biassed answer because the price of butter is also influenced by supply conditions in the dairy industry. This creates the so-called identification problem, namely, the question of whether it is possible to identify a demand curve or a supply curve from observed price–quantity data. The use of simultaneous equation models to estimate economic relationships is by now perhaps the best way of distinguishing econometrics from economic statistics.

The foregoing discussion covers only nine major branches of economics. There are many other fields in economics, including economic history, comparative economic systems, business cycles, economic forecasting, national income accounting, managerial economics, business finance, marketing, the economics of natural resources, economic geography, consumer economics, and regional economics.

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