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General Thought-Schemes and The Economist

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GENERAL THOUGHT–SCHEMES AND THE ECONOMIST

Introduction*

In the scholarly life, a young man is a traveller, an old man is a traffic policeman. The young man is seeking the footprints of his predecessors across a land unknown to him, or better, he is building a road across it. The old man is warning, advising and encouraging the travellers, and pointing out the mountain pass from which there will be seen, who knows what spreading landscape ? In his recent Presidential address to the British Association, Sir Charles Carter urged the business man to give his thoughts and visions 'breadth'. Economics is the study of human affairs. It is concerned in especial with a few aspects or themes of those affairs, but these themes are all chapters of one book and must be read with an awareness that the rest of the book exists and every part of it in some degree illuminates every other. This idea of the underlying unity of the human condition, the idea that whatever our purpose, the basic rules which condition our efforts are the same, was the inspiration of my lecture on 'General Thought-Schemes and the Economist. There I suggested, for example, the almost universal immanence of the idea of classification. A concept springs into being when we delineate a class of things. When we measure, we classify: all objects are the same length, which differ by less than the smallest discriminable interval. Momentous fields of activity rest in an essential way on classification: the law in so far as it depends on precedent; medicine in the sense that diagnosis of disease consists in classifying it with a view to the selection of appropriate treatment. The notion of function in mathematics is a cross-classification of the values or two or several variables. If economic theory should come to feel itself in need of a fresh start, might it not do well to step back from the present work-bench with its crowded tools and start afresh, in some degree, from so simple and elemental a notion as classification, the art of the filing-system?

Since I wrote my lecture, I have come to feel more strongly the value of distinguishing two styles of thought. There is the axiomatic style, which deals directly with an abstract system whose elements are defined only in relation to each other, so that it can only make suggestions about the world of experience by seeing in that world an analogy to itself in some respects. It is only in respect of a purely abstract system that rigorous proof is possible. The world of experience is unthinkably too various, rich, vague, complex and imprecise for logical demonstration to be possible by direct application to that world itself. By contrast, there is the rhetorical style. The rhetorician, in common with the poet, is willing to use the full compass of meaning in any word he employs. Thus he stands at the other semantic pole from the pure logician, for whom a word's meaning must be singular to the last degree. The rhetorician deals, not in proof but in suggestion. Imprecision is, in his discourse, not a flaw, not a

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* This is a slightly revised version of my lecture given at the then Woolwich Polytechnic, some twenty years ago. That lecture was subsequently published as No. 2 Woolwich Economic Papers (March 1964).

shortcoming, but an essential characteristic resource. It is the rhetorician's art to touch the harp-strings of individual imagination, to gain, not grammatical assent but a response, partly aesthetic, to find empathy in his reader's or his hearer's mind.

The mathematicians now seek to bridge the rift that separates the austerity of logic from the copiousness, the stretchable receptiveness of rhetoric. The theme of Zadeh's 'fuzzy sub-sets' is an enlargement of mathematics in this direction. This is the exciting development now proceeding, especially in France, where economic theory now has at its disposal 'les sous-ensembles flous'.

Schemes of Thought in Economics

We are prisoners of ideas. Before we can act in regard to any thing, we must be able to think about that thing, before we can think about it we must recognize it or conceive its nature, to recognize or have a conception of something is to classify it, is to give it a place in some scheme of thought, such schemes of thought are supplied to us ready made by our environment, our education, our social intercourse. Thus for the most part we can think, and can shape our conduct, only in accord with certain stereotypes. Imagination itself, the characteristic and most supremely human faculty, is perhaps no more than the composition of mosaics with *tesserae* that experience, personal and ancestral, has supplied.

If such be accepted, some questions present themselves. Most fundamental, most important to our human self-esteem, is the question whether we can ever break out of our prison. Can we at times invent new thoughts, thoughts of new kinds, can reason transcend itself to make new structures of reasoning? Greater and less, addition and subtraction, earlier and later, cause and effect, knowledge and ignorance, permanence and evolution; is everything that we can think, every thought that we can have, no more than a shuffling together of these elements and elements like them, into patterns which have been eternally possible, merely waiting to be realized? This is the most interesting question; but in so far as I hope to touch on it at all, I can do so only in discussing one aspect of a different and humbler question, namely, that of the mutual compatibility of our established stereotypes of thought, the inter-communication, as it were, of the various cells of our prison.

If I were asked: What is Science? I would answer: Science is classification. It involves, of course, the whole art and business of inventing the classes of entities and that of establishing their inter-sections, in fact, the whole business of imagining, of creating, the scheme of classification which can take care of all the possibilities of nature and society, in so far as these possibilities manifest themselves in repetition. It is repetition which allows of science. When men try to make history into a science, they do so by seeking repetitivenesss in the phases of growth and decline of civilizations, or of technologies, or of business cycles, or of 'growth'. What is an explanation of some phenomenon? It consists in saying '*That* belongs *here*'. Suppose I feel a sudden sharp pain in

my arm. Am I worried? No, because I have observed a small yellow creature crawling on my arm. I file the pain at once under 'wasp stings'. It is 'explained'. This classification intersects with, and is indeed contained within, another pigeon-hole labelled 'Injuries not usually serious'. All this amounts to knowledge, and this knowledge has been achieved by classification.

It is cross-classification which principally gives us knowledge, for then we find associations between one state of affairs and another, we discern structure in our surroundings. If one of two frequently associated states seems each time to precede the other, we are tempted to call it a *cause* of the other state. This temptation may be re-inforced if we can show that the operation of this 'cause' is merely a special type of a much wider class of instances where something analogous happens. Structure, however, is a more general idea than cause, and does not depend on it. Structure is mathematically expressed by the idea of function, the idea of a rule which restricts in some specific way the sets of measurements which we compose into vectors or points and the sets of such vectors or points which we compose into curves, surfaces and other varieties. In examining the mutual compatibility of the thought-schemes which, by whatever agency, impose themselves upon us, it seems appropriate to begin with function and cause.

Suppose we have seven kinds of phenomena A, B, ...G, and that we use these letters as labels of the rows of a rectangular array of 'empty boxes'. And suppose T, U, . . .Z, are seven other kinds of phenomena which we use as labels of the columns of the same rectangular array. If observation shows us only instances which we can file into the boxes AT, BU, CV, DW, EX, FY, or GZ, and that the observable world appears to leave the other boxes empty, we have already a piece of cross-classificatory knowledge, we have a restrictive pattern by which certain phenomena appear to be regularly and exclusively associated, we have a glimpse of structure. The 'kinds of phenomena' A, B, ... need not be widely diverse in qualitative character. Instead, they may be merely different members of some class of measurements defined by its unified subject-matter, they may, that is to say, be different numerical values of some variable. If the other list of phenomena, T, U, ..., are also merely different items in a class of actual or conceivable measurements, the pattern displayed by our rectangular array will be a function in the mathematician's sense, it will restrict the pairs or sets of values, one from each of a list of variables, which it allows, or we can say more briefly, it will define a class of vectors or points.

Now the word 'cause' suggests activity, change, event, followed by some other such change or event which would not have happened if the former event, or something equivalent, had not occurred. It is obvious that the idea of function is quite different from this. If we have a circle of known radius, we can calculate its circumference to as good as approximation as we like. But here there is no event, except our act of measuring the circle, it would be quite out of touch with ordinary usage to say that the radius of the circle 'causes' the circumference to be such and such, for why should we not say that the circumference causes the radius to be such-and-such? However abstract its

mathematical origins or the modern analyst's interpretation of it, the idea of function is plainly invaluable in describing the structure of our physical world. A mathematician would be prepared to assume, at least for the sake of argument, that the whole cosmos and everything that goes on in it could in principle, and if we had 'room and time enough' be described, stated and set down as a function, $F \equiv 0$. But if everything were thus accounted for, in a complete inter-locking of all phenomena, what room would there be for any notion of 'cause'? The idea of a function totally describing the whole nature and history of the cosmos, past and future, would not be that of a mathematical machine tool into which we can put raw data and get out finished conclusions, for plainly there would be no question of choosing what data to put in: the only answer the function would give us is: The cosmos is like this; or even: The cosmos is this. To use the notion of 'cause and effect' seems to imply an absence of all-pervading determinism in the cosmos. Except in so far as the 'cause and effect' locution is merely a way of directing attention to certain aspects or portions of the total, inter-locking structure of things, of singling out particular features of this structure, this way of speaking seems to imply that there are *sources* of trains of events, sources in somewhat the physicist's sense of the word when he speaks of 'sources' and 'sinks' of energy in some region or system. If all causes are themselves determinately and precisely caused, we are in a complete determinist universe where nothing can happen differently from what it does.

Is it useful, then, to give a more substantial meaning to 'cause', to make it mean something characterizing the world itself and not merely our method of examining that world? When we elect, as economists among other investigators do, to single out two, or very few, phenomena at a time and examine their mutual influences and interactions against a supposedly fixed and passive background of other things, then we are using one of the characteristic and indispensable methods of science, the experimental method or something as close to it as social scientists can get. It is surely legitimate in such a procedure, if we find that by bringing about phenomenon A we can in the right circumstances always produce B, but that we cannot produce A by bringing about B, to call A in these circumstances the 'cause' of B. But here we have our clue. We spoke of 'bringing about' phenomenon A. If we look upon this 'bringing about' as in the strict sense an initiative of our own, something itself 'uncaused', then we are thinking of the physical world as equipped with countless levers available for human beings to manipulate and so produce effects which they may expect and desire. We are regarding the world, in its state at any moment, as an incomplete system, one whose immediately future behaviour depends on the way in which data or impulses not deducible in character or quantity from the past of the system, are going to be fed into it *ex nihilo* by human agency.

if-020 Now you may well feel that to set apart from each other in this way, to regard as subject to quite different modes of being, the human and the non-human world, is too much to accept. Consciousness, it may be held, does not imply enfranchisement from the 'laws of nature'. But if so, are we not in a purely determinist world, where it must be doubted whether the economist's peculiar concentration on what he calls 'choice' can be justified? Why bother with

choice' when choice is merely subservience to necessity? Why call it choice, when we merely go the way our chains compel?

What, then, is the economist's basic pre-supposition about the world he studies? His purpose is to understand it scientifically. A scientific explanation, I have ventured, however recklessly, to suggest, is in essence an act of rather complex classification. We sort things into kinds, and as long as our classificatory scheme holds out, and offers us the necessary pigeon-hole, we are happy enough. I even tried to persuade you that mathematical analysis itself can be looked on in this light. The economist, then, finds that particular box in his scheme, where the class 'reductions of price' intersects the class 'extensions of demand' filling up very rapidly as he files his observations. From this fact, if he is an empiricist, he draws a so-called 'law'. Another box collects the cases where large and rapid increases in the quantity of money have been accompanied by rising prices, and shows, perhaps, more instances than the box where a rising general prive-level intersects with a constant or falling stock of money. (These are crude illustrations, not meant to stand up to detailed criticism; I well know the trouble that statisticians or econometricians have had, even with multiple correlation methods, in sorting out their observations so as to make theoretical sense.) Then the theoretician takes over. He proposes ideas, such as that of diminishing marginal rates of substitution, which enable us to enclose our observed phenomena in still wider and more general classes, giving us a greater sense of explanatory power and of the unity and coherence of the social and economic organism or mechanism. And all this time the economist is relying upon repetitiveness, upon a basic uniformity in the texture of economic life. How, then, is he going to explain invention, development, evolution, irreversible change?

The problem whether science can explain evolutionary, one-way changes seems to me a fundamentally important one. I have already referred to the example of human history in the conventional sense. Those historians, such as Spengler and Toynbee, who have tried to scientificize history have had to resort to repetitiveness. Their latest recruit is Mr. Walt Rostow of the *Five Stages of Economic Growth.* But even he has to admit one stupendous anomaly, or at any rate, one great question that no appeal to repetitiveness can answer. How did the very first 'take-off into self-sustained growth', the original and British one, happen? In the biological sciences, evolution is accounted for by a mechanism or several distinct mechanisms. But at least one of these has a very interesting essential feature, whose implications are quite startling once you have thought about them. It depends upon *random* change. Irreversible changes occur in the transmissible detailed design of some living creature. A particular specimen differs from anything that can be accounted for by its ancestry, yet this modification is passed on to its off-spring. When the off-spring of such random mutants find themselves, by reason of this change, specially well equipped to cope with some available environment, they thrive, multiply and oust their less well adapted rivals. Thus forest-dwelling apes get on well with their long arms, which are the reason, not the result, of their adoption of the forest habitat. *Homo* self-styled *sapiens* has prospered by his erect posture, which enabled him to grasp things with his

hands now freed from their duty as feet, to inspect these things closely on all sides with a long leisurely stare of curiosity, to throw them around, as toys, as weapons, as tools . . . . He began to think about them, he began to think about things *such as* them, he remembered what he had done and sought to do a like thing again . . . . A *like* thing? This was to classify, to conceive abstract ideas. Concept-making man had come. And the secret of all this, we are told, is *random* genetic mutation.

So history is random? This is at least an escape from 'history is determined from the beginning of time'. Economic theory in recent years has taken quite definitely (I do not know whether to say 'deliberately': there were no committee-meetings about it) a particular turning, has adopted a particular policy, in response to the challenge of this past seventy years of war, revolution, depression and general social upheaval. It was plainly necessary to have theories going beyond the mere explanation of a state of general, perfect and fully-informed adjustment, where within an unchanging institutional and political environment it was supposed that the inborn tastes and the given skills and possessions of all the very various members of the society would be accommodated to each other 'optimally', so that when each person had perfect and therefore equal knowledge of the circumstances, potential and actual, which faced him, and also had equal freedom, he would elect that course of action best serving his own interests; serve them best, that is, given that everyone else would similarly serve his own interests. This equilibrium scheme of thought was, so far as it went, a miracle of efficiency and incisive explanatory power. But it did not explain change, and so, of itself, it could do nothing to explain history. So the economists had to think again. They saw, first of all, the business cycle; that splendidly repetitive phenomenon which nevertheless described events and not mere situations. Business cycle theories began by being very makeshift affairs. A business cycle consists of a number of phases, so for each phase we will have an explanation, was the first approach. Nowadays we have business cycle machines, models which by their very design are bound to respond to any impulse or shock by producing oscillations. The precise behaviour of such a machine depends solely on two classes of data: first, its own detailed design, expressed in equations which bind functionally together events which are supposed to occur at different dates; and secondly, the exact force of the shock from outside the machine which throws it out of its equilibrium state or path of steady, e.g. exponential, movement. Slight changes in the parameters of the equations may make all the difference to the kind of oscillation, damped or anti-damped, that the machine produces, but these parameters are, in a sense, the sole expression, within the model, of all the psychic, social, political and institutional influences that govern people's response to particular economic circumstances. For the unreality of perfect all-pervasive relevant knowledge, supposed to be possessed by all the members of the society and to include simultaneous knowledge about each others' thoughts, we have substituted the artificiality of mechanism, behaviour which can be described without any mention of thought, choice, decision. Whether it adopts an equilibrium model or a cyclical one, economic theory seems resolved to treat economic conduct as mere response.

But if we have no other principle than mere consistent response to the existent circumstances we are in a perfectly determinist hypothetical world. There seem to be two ways of escape. We can appeal to some fundamental randomness in things, manifested for example in genetic mutation and actually arising in sub-atomic structure. Or we can suppose that human thought is more than mere response.

There is an arresting contrast between the unquestioning sense of personal, originative, history-making power afforded us by any private act, however humble, of decision, and the passivity, the mere mechanical subservience or mathematical determinism implicit in the attempts we make as scholars to unravel the driving motives and shaping circumstances of the deeds of other people. For each of us his own decision, surrounded as it is by compelling circumstance, by weighty considerations, moral pressures, desires, tastes, habits and the whole authority of social life, yet seems to have a central freedom, a void to be filled by a new spring of initiative in our own mind. Decision, when it is the real and living act emerging into our own private consciousness, seems to us to come in some degree *ex nihilo*. Yet we look upon ourselves as rational, as trying to respond to circumstances, to do our best with the situation presented to us, to make what we can of the materials given to us. How can these two attitudes, these two meanings ascribed to human action, be mutually reconciled? Do we make history or merely enact it? Do we speak parts written for us or spontaneously improvise them ourselves?

Decision is choice, but choice amongst what? Not amongst actual experiences depending upon stimuli from without or our own motor responses, for when you are actually experiencing or physically doing something, it is too late to reject it in favour of something else. Choice is amongst imagined experiences. And when a man summons up an array of imaginations, how does he know what action-course will actualize any one such picture? Or when, instead, he reviews his rival available acts, how does he know what outcome to attach to each? He does not and cannot know. But can he perhaps make a list of all possible consequences of each rival available act, and thus call to his aid all the apparatus of the theory of distributive probability? Even in a fundamentally random universe, statistics might rescue him. But not in a universe of ultimately creative thought. If a thought can contain an element undeducible from any record of the thinker's past no matter how perfect, by any logical process no matter how powerful, then in principle no list can ever be made which can be known to be complete, of the distinct outcomes which a decision-maker might invent or imagine for any action-course open to him. If so, distributive probability can have no application to his problem of choice amongst actions. For probabilities can only be meaningfully assigned to the items of a complete list of contingencies, or to the intervals of a variable whose meaning is in stable dependence on such a list.

There are many interpretations of the word probability, many different prescriptions for assigning probabilities to contingencies and for using the resulting distribution for practical guidance in action. The common factor in all these ideas is contained in the word distribution. The notion of probability

depends upon the combined presence (i) of an exhaustive list of possible outcomes of some carefully specified type of performance or trial, and (ii) of some procedure or argument for assigning to each item in this list a share of a fixed total, usually taken to be the number one, representing the certainty, implicit in the exhaustiveness of the list, that one or other of the listed results must occur.

The distributive procedure depends in the last analysis on dividing the whole field of possibilities into elements each of which is on the same footing, in the matter of claiming a share of 'probability', as each of the others, so that these elements are equi-probable. Then any outcome, whose realization consists in the realization of any one of several elements, will be assigned the total of the probabilities of all those elements. What we are here to mean by 'on the same footing' is one of the central semantic problems of probability theory, but it can be practically resolved either *a priori,* as by claiming, for example, that the die with its six faces is symmetrical and therefore we have no reason to regard one face as more probable than another, or *a posteriori,* by examining the statistical record of a 'large number' of trials. What seems to me plain is that none of these ideas or procedures would make sense unless we were able to assume a given field of possibilities. *A priori* assignment of probabilities requires us to know enough about the contingencies to assure ourselves of their symmetry. Statistics may absolve us from knowing about ultimately 'individual' contingencies by giving us information about the frequency of 'outcomes' which can claim realization in the case of realization of any one of several contingencies. But statistics will evidently not tell a meaningful story unless the universe which is being sampled stays the same universe. When we imagine a universe of thoughts, and elect to suppose that new thoughts can pour into this universe *ex nihilo,* we have not got a stable basis for statistical probability.

Economic theory faces a basic dilemma, which it was Keynes's chief contribution to begin to make explicit. The aim of a science is coherence. It must take for granted a number of undefinables, ideas of which it gives no account but merely names them and possibly points to examples of them. These things may be undefined only within the bounds of the particular science itself, finding their descriptions and explanations in terms of another science; or they may be the ultimate undefined terms of mathematics, such as 'successor'. Given these elements, the science seeks to compose from them a structure reducible to the application of comparatively few principles. Thus, granted only the right to leave certain items undefined, the science hopes to be able to analyse completely any situation which comes within its scope. For a science concerned with human conduct, with human choice of action, this means that every action, or event composed of actions, must be accountable as the upshot of specifiable circumstances or pressures, it must be exhibited as the inevitable outcome of a pre-existing combination of factors. But what becomes, in this case, of a human capacity, if we believe in it, for unpredictable thoughts? What becomes of imagination, invention, social evolution? Economics, it seems, can try to be a science like chemistry, or it can try to explain the life of human beings, but not both.

What human beings do depends on what they know. If, under 'know' we include all their beliefs, assumptions and conjectures, and everything which enters into their description of the state and nature of the world, we shall have expressed in that sentence what it is which mainly prevents economics from being scientific in the way that chemistry or mechanics are. For it is intensely difficult, within a theory simple enough to deserve the name, to show exactly how and with what success people can find out, not only about a passive environment, but about each other's contemporary intentions and about each other's state of knowledge, which last presents us evidently with the problem of an infinite regress. These difficulties have not been properly recognized by economists. The whole brilliant, incisive and all-incisive neo-classical theory of value, brought to perfection by Walras and Pareto, Wicksteed and Wicksell about the turn of the present century, depended on the astounding assumption that people know everything relevant to their choices. The question what this knowledge must consist of and how it is to be obtained is cut out by an Alexandrine sword-stroke of superb efficiency: the notion of general equilibrium. General equilibrium, when we look at it as a solution to the problem of knowledge, turns out to mean that people exchange conditional promises of action, only finally committing themselves to specific action when the system of these conditionals has been solved as a whole to indicate for each person the action that he prefers given that everyone else elects and performs that particular action which the solution prescribes for him. And how is it conceivable that such a system, of indescribable complexity, can be solved? So simply, the requisite knowledge for each person, though it includes all the detailed actions of 'other people' in making, buying and selling goods, really amounts to no more than the *prices* of these goods; and these prices are determined on that extremely powerful if not absolutely accurate computer, the market.

The greatest paradox which the idea of knowledge brings into economic theory is that of knowledge as a commodity. How much is it worth while to pay for knowledge? No one can know until he has acquired the knowledge, and before then he will have had to pay for it, by way of the costs of a research programme or the purchase of a secret or, more prosaically, the purchase of an entertainment, a visit to the theatre, a copy of a novel or of a newspaper. Who knows what he will get for the twentypenny price of *The Times*? Who would buy *The Times* if he knew precisely, completely and for certain what was in it? Economics is the study of how men seek to cope with two of the great basic, inescapable, conditions of life: scarcity, or lack of means; and uncertainty, or lack of knowledge. But economic theory cannot bring lack of knowledge under the same sort of analysis as lack of material means. The possession or the non-possession of knowledge alters everything. An equilibrium analysis of the role of knowledge as a commodity is a contradiction in terms. Equilibrium copes with scarcity on the assumption that the problem of knowledge is solved.

But general equilibrium with all its splendour and incomparable intellectual efficiency, reducing everything to the logic of maximization, only describes a momentary world. The world of change, evolution and invention is quite

beyond its scope. What, then, of prediction? Is not the power to predict said to be the mark and test of science? In what sense and degree can economics claim to be predictive?

But first, in what sense can other sciences claim to be predictive? We have to make an absolutely vital though very obvious distinction between prediction and prophecy. Scientific predictions, those statements which are implied by some theory and which therefore serve to test it, are conditional statements. They say: If such and such a set of circumstances is brought about, or found somewhere to exist, these will be accompanied or followed in time by such and such other circumstances. The predictions of science are merely a mode of its description of nature. A theory begins with 'a minimal description of what is'. This minimal description, treated as a set of axioms, logically implies a volume of other general propositions and particular assertions. If we find that these latter are falsified under practical test or observation, the theory must be modified or replaced with another. To make a scientific prediction is to suggest what will be the completion of a picture which is already partly filled in, it is not to say what picture is going to appear on a blank canvas. A scientific prediction starts with *if*. Now to suggest the future course of human events can only resemble scientific prediction if the described events are to arise out of a known configuration of desires, beliefs, intentions and resources, and such knowledge, if it can ever be possessed by anyone, can at the utmost refer only to the present. Prediction of human events can be scientific only if it refers to the immediate future.

Prediction of how human beings are about to act in the most immediate future, prediction of very short range indeed, might claim a formal respectability if it were conceivable that the tensions and intentions of society and individuals at the present moment could be known in detail, and if it were claimed that those new thoughts, whose coming to birth we have invoked as a release from determinism, would take some time to have any marked public effect on affairs. There is perhaps a more strange possibility. If we regard the more cataclysmic social events as the sudden bursting of restraint by latent forces which have built themselves up gradually over many years, we can conceive that the character, configuration and strength of these forces might be discerned as they came into being, so that the shape, but not the date, of the eventual upheaval might be described. To have a name for this conception, the perceived pattern of latent social or economic forces which have gathered strength and only await some 'signal', some event which should reveal the partisans to each other and tip the scale of impatience, I have elsewhere suggested the word 'rig'. The power to discern the 'rig' and the readiness to effect an orderly and quiet release of its pressures is the mark of political maturity. If such pre-vision had any reality, it would still be in effect a short-range prediction, for at most it could hope only to describe the immediate sequel to the release of the latent forces. Since that release might result from any one of an infinity of different sorts of accident, the date of this release would remain utterly unforeseeable. All this does little to advance the claims of economic or political 'science' to be scientific in the manner of the natural sciences. Do they really wish to make that claim? To do so is to make

nonsense of our practical, intuitive, unselfconscious interpretation of our own most serious individual feelings. It implies that the absorbed thought and pressing anxiety which mark our efforts to reach a decision in some important matter are mere side-effects of the operations of a fateful mechanism, perhaps necessary to the working of this mechanism but quite deceptive in the burden they seem to place on the individual conscience and capacity. Decisions can be anguishing. But does, or need, a machine feel angish? If the cosmos is a vast computer programmed from the beginning of time, what need is there for consciousness itself? But if consciousness is the vehicle of a true creative activity, an ultimate source of events unimplied by what has gone before, then we can understand its purpose.

It may seem to you that I have strayed from my brief or terms of reference. Many economists would impatiently reject or deride the preoccupations I have suggested to you. But I believe them to be important. How can economics be a success, a practically effective illuminant of history's ever-untrodden road, unless its ambitions conform with the realities of the human condition? What can economic theory really hope to give us by way of practical tools?

I want to suggest to you the notion of the sterotype. The ordinary business of living from hour to hour involves countless repetitions of a great number of diverse kinds of drill. By a drill I mean a settled procedure, from the elementary act of turning a light-switch to the sophisticated following-out of a cooking recipe. In each such drill we have a sequence of operations and a more-or-less confidently expected result. Without these drills and our unquestioning reliance on their efficiency we could never keep up with the ceaseless and relentless demands of life. These drills are small spotlighted areas in the vast dark stage of the environment. What would be the good of turning a light switch, if there did not exist the tremendous organization and instrumentation of the Central Electricity Generating Board and the Grid? What would be the good of posting a letter if the Post Office were not there to take charge of it? We do not have to know how one Board generates and other Boards distribute electricity, or how the automatic exchanges enable our telephone call to get through, in order to press the technological frame of life into service. There is an orderliness in our surroundings which we rely on, only needing to understand a fairly small part of the whole process which gives effect to our wishes. Each of us builds the unique structure of his or her personal existence out of countless stereotyped patterns of action. The letter you compose is unique, unparalleled, strictly matchless. But it uses language, the most marvellous of stereotypes in the contrast between its infinite flexibility, subtlety and power, and its rigid forms of word shape, vocabulary and grammar. If, now, stereotypes or drills play so large a part in our small-scale business of personal living, is it not likely that they are the heart of the matter in the larger-scale business of public policy? For it is stereotypes that economic theory in the first place provides.

Alfred Marshall's 'bit at a time' method does not do all that is required of theory. It is liable to mislead us in such matters as the theory of employment, where it tempts us to use the familiar demand-and-supply analysis that we

apply to a single consumable, and to assume that the supply curve and the demand curve can be drawn independently of each other. When the thing being dealt in is labour, a rise in the price cannot fail to alter the society's income and thus its demand for commodities and thus its demand for labour, so that a movement along one curve requires us to re-draw the other. Also again, in fiscal theory, it will not do to consider the effects of taxation separately from those of government expenditure. I would say, indeed, that the most important lesson to be learned from economics is the universal inter-dependence of all economic variables. The test of a natural-born economist is whether this idea is the ever-present, tacitly and unquestioningly accepted background to all his economic thinking. Yet Marshall's method is the proper basis for our work. It shows in concrete detail how things happen. It provides the essential stereotypes: the supply-curve and all that can be read into it and extracted from it; the mode of growth of firms and industries; the relation of demand to price. Marshall gives us the pieces to handle, and an intimate familiarity with these pieces is as vital as a grasp of the Grand Design that Walras or that Keynes conceived, and it is as indispensable as those studies of comprehensive consistency or coherence which are nowadays so prominent under the names of 'indicative over-all planning' or 'the Social Accounting Matrix'. These powerful schematizations and projections ultimately rest on an understanding of the stereotypes: the consumption-function, the Multiplier, the propensity to import, the Accelerator, the full employment ceiling, the capital-output ratio, liquidity preference, the price and income elasticities of demand, the interest-elasticity of investment, and so forth.

Conclusion

There is one more general idea, with its special economic embodiment, that I would like to use as my conclusion. It is this very idea of coherence that I have just referred to. Although I have stressed stereotypes or models of simple action-and-consequence configurations or of repetitive associations of circumstance, there remains the vital truth that these are but tiles composing the great mosaic picture of society's business as a whole. This total picture, in order to be convincing and beautiful, must itself be a coherent unity where everything fits together without loose ends. The method of ensuring this is a kind of accounting, called Social Accounting, which, in its most modern, elegant, efficient and powerful form, makes use of a branch of mathematics called matrix algebra. The use it makes of this is chiefly notational, and indeed the manipulative aspect is fortunately nowadays taken care of by the electronic computer. The social accounting matrix is the visible embodiment of coherence in a general economic scheme, for each entry in the table plays a double role, showing by its position both the source and the destination of the *valuturn* concerned. This scheme has evolved from the brilliant invention of input-output analysis by Wassily Leontief in the early 1930's, whereby he showed how the detailed response required of a complex productive web of industries supplying and drawing upon each other, when the final 'bill of goods' to be delivered as the end-product of this productive machine was changed in a specified way, could be calculated, as it were, at one stroke

(even though that 'stroke' consisted in the solution of a great system of equations, or the inversion of a very large matrix). It is, I believe, in the development of these comprehensive 'schemes of coherence', embracing the whole economy and yet, like a great microscope, able to resolve an astonishing degree of detail, that economics has the best hope of justifying itself as a tool of the human mind able to match, though not to imitate, the achievements of the natural sciences.

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