Rationality of Self and Others in an Economic System

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Standard economic doctrine makes assumptions of rationality that have very strong implications for the complexity of individuals' decision processes. The most complete assumptions of competitive general equilibrium theory require that all future and contingent prices exist and be known. In fact, of course, not all these markets exist. The incompleteness of markets has several side consequences for rationality. For one thing, each decision maker has to have a model that predicts the future spot prices. This is an informational burden of an entirely different magnitude than simply optimizing at known prices. It involves all the complexity of rational analysis of data and contradicts the much-praised informational economy of the price system. It is also the case that equilibria become much less well defined. Similar problems occur with imperfect competition.

I. Orientation

In this paper, I want to disentangle some of the senses in which the hypothesis of rationality is used in economic theory. In particular, I want to stress that rationality is not a property of the individual alone, although it is usually presented that way. Rather, it gathers not only its force but also its very meaning from the social context in which it is embedded. It is most plausible under very ideal conditions. When these conditions cease to hold, the rationality assumptions become strained and possibly even self-contradictory. They certainly imply an ability at information processing and calculation that is far beyond the feasible and that cannot well be justified as the result of learning and adaptation.

Let me dismiss a point of view that is perhaps not always articulated but seems implicit in many writings. It seems to be asserted that a theory of the economy must be based on rationality, as a matter of principle. Otherwise, there can be no theory. This position has even been maintained by some who accept that economic behavior is not completely rational. John Stuart Mill (1909, bk. 2, ch. 4) argued that custom, not competition, governs much of the economic world. But he adds that the only possible theory is that

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based on competition (which, in his theories, includes certain elements of rationality, particularly shifting capital and labor to activities that yield higher returns): "Only through the principle of competition has political economy any pretension to the character of a science" (1909, p. 242).

Certainly, there is no general principle that prevents the creation of an economic theory based on other hypotheses than that of rationality. There are indeed some conditions that must be laid down for an acceptable theoretical analysis of the economy. Most centrally, it must include a theory of market interactions, corresponding to market clearing in the neoclassical general equilibrium theory. But as far as individual behavior is concerned, any coherent theory of reactions to the stimuli appropriate in an economic context (prices in the simplest case) could in principle lead to a theory of the economy. In the case of consumer demand, the budget constraint must be satisfied, but many theories can easily be devised that are quite different from utility maximization. For example, habit formation can be made into a theory; for a given price-income change, choose the bundle that satisfies the budget constraint and that requires the least change (in some suitably defined sense) from the previous consumption bundle. Though there is an optimization in this theory, it is different from utility maximization; for example, if prices and income return to their initial levels after several alterations, the final bundle purchased will not be the same as the initial. This theory would strike many lay observers as plausible, yet it is not rational as economists have used that term. Without belaboring the point, I simply observe that this theory is not only a logically complete explanation of behavior but one that is more powerful than standard theory and at least as capable of being tested.

Not only is it possible to devise complete models of the economy on hypotheses other than rationality, but in fact virtually every practical theory of macroeconomics is partly so based. The price- and wage-rigidity elements of Keynesian theory are hard to fit into a rational framework, though some valiant efforts have been made. In the original form, the multiplier was derived from a consumption function depending only on current income. Theories more nearly based on rationality make consumption depend on lifetime or "permanent" income and reduce the magnitude of the multiplier and, with it, the explanatory power of the Keynesian model. But if the Keynesian model is a natural target of criticism by the upholders of universal rationality, it must be added that monetarism is no better. I know of no serious derivation of the demand for money from a rational optimization. The loose arguments that substitute for a true derivation, Friedman's economizing on shoe leather or Tobin's transaction demand based on costs of buying and selling bonds, introduce assumptions incompatible with the costless markets otherwise assumed. The use of rationality in these argu-

ments is ritualistic, not essential. Further, the arguments used would not suggest a very stable relation but rather one that would change quickly with any of the considerable changes in the structure and technology of finance. Yet the stability of the demand function for money must be essential to any form of monetarism, not excluding those rational expectations models in which the quantity theory plays a major role.

I believe that similar observations can be made about a great many other areas of applied economics. Rationality hypotheses are partial and frequently, if not always, supplemented by assumptions of a different character.

So far, I have simply argued that rationality is not in principle essential to a theory of the economy, and, in fact, theories with direct application usually use assumptions of a different nature. This was simply to clear the ground so that we can discuss the role of rationality in economic theory. As remarked earlier, rationality in application is not merely a property of the individual. Its useful and powerful implications derive from the conjunction of individual rationality and the other basic concepts of neoclassical theory—equilibrium, competition, and completeness of markets. The importance of all these assumptions was first made explicit by Frank Knight (1921, pp. 76–79). In the terms of Knight's one-time student, Edward Chamberlin (1950, pp. 6–7), we need not merely pure but perfect competition before the rationality hypotheses have their full power.

It is this theme on which I will largely expand. When these assumptions fail, the very concept of rationality becomes threatened, because perceptions of others and, in particular, of their rationality become part of one's own rationality. Even if there is a consistent meaning, it will involve computational and informational demands totally at variance with the traditional economic theorist's view of the decentralized economy.

Let me add one parenthetic remark to this section. Even if we make all the structural assumptions needed for perfect competition (whatever is needed by way of knowledge, concavity in production, absence of sufficient size to create market power, etc.), a question remains. How can equilibrium be established? The attainment of equilibrium requires a disequilibrium process. What does rational behavior mean in the presence of disequilibrium? Do individuals speculate on the equilibrating process? If they do, can the disequilibrium be regarded as, in some sense, a higher-order equilibrium process? Since no one has market power, no one sets prices; yet they are set and changed. There are no good answers to these questions, and I do not pursue them. But they do illustrate the conceptual difficulties of rationality in a multiperson world.

II. Rationality as Maximization in the History of Economic Thought

Economic theory, since it has been systematic, has been based on some notion of rationality. Among the classical economists, such as Smith and Ricardo, rationality had the limited meaning of preferring more to less; capitalists choose to invest in the industry yielding the highest rate of return, landlords rent their property to the highest bidder, while no one pays for land more than it is worth in product. Scattered remarks about technological substitution, particularly in Ricardo, can be interpreted as taking for granted that, in a competitive environment, firms choose factor proportions, when they are variable, so as to minimize unit costs. To be generous about it, their rationality hypothesis was the maximization of profits by the firm, although this formulation was not explicitly achieved in full generality until the 1880s.

There is no hypothesis of rationality on the side of consumers among the classicists. Not until John Stuart Mill did any of the English classical economists even recognize the idea that demand might depend on price. Cournot had the concept a bit earlier, but neither Mill nor Cournot noticed—although it is obvious from the budget constraint alone—that the demand for any commodity must depend on the prices of all commodities. That insight remained for the great pioneers of the marginalist revolution, Jevons, Walras, and Menger (anticipated, to be sure, by the Gregor Mendel of economics, H. H. Gossen, whose major work, completely unnoticed at the time of publication [1854], has now been translated into English [1983]). Their rationality hypothesis for the consumer was the maximization of utility under a budget constraint. With this formulation, the definition of demand as a function of all prices was an immediate implication, and it became possible to formulate the general equilibrium of the economy.

The main points in the further development of the utility theory of the consumer are well-known. (1) Rational behavior is an ordinal property. (2) The assumption that an individual is behaving rationally has indeed some observable implications, the Slutsky relations, but without further assumptions, they are not very strong. (3) In the aggregate, the hypothesis of rational behavior has in general no implications; that is, for any set of aggregate excess demand functions, there is a choice of preference maps and of initial endowments, one for each individual in the economy, whose maximization implies the given aggregate excess demand functions (Sonnenschein 1973; Mantel 1974; Debreu 1974; for a survey, see Shafer and Sonnenschein [1982, sec. 4]).

The implications of the last two remarks are in contradiction to the very large bodies of empirical and theoretical research, which draw powerful implications from utility maximization for, respectively, the behavior of individuals, most especially in the field of labor supply, and

the performance of the macroeconomy based on "new classical" or "rational expectations" models. In both domains, this power is obtained by adding strong supplementary assumptions to the general model of rationality. Most prevalent of all is the assumption that all individuals have the same utility function (or at least that they differ only in broad categories based on observable magnitudes, such as family size). But this postulate leads to curious and, to my mind, serious difficulties in the interpretation of evidence. Consider the simplest models of human capital formation. Cross-sectional evidence shows an increase of wages with education or experience, and this is interpreted as a return on investment in the form of forgone income and other costs. But if all individuals are alike, why do they not make the same choice? Why do we observe a dispersion? In the human capital model (a particular application of the rationality hypothesis), the only explanation must be that individuals are not alike, either in ability or in tastes. But in that case the cross-sectional evidence is telling us about an inextricable mixture of individual differences and productivity effects. Analogously, in macroeconomic models involving durable assets, especially securities, the assumption of homogeneous agents implies that there will never be any trading, though there will be changes in prices.

This dilemma is intrinsic. If agents are all alike, there is really no room for trade. The very basis of economic analysis, from Smith on, is the existence of differences in agents. But if agents are different in unspecifiable ways, then remark 3 above shows that very little, if any, inferences can be made. This problem, incidentally, already exists in Smith's discussion of wage differences. Smith did not believe in intrinsic differences in ability; a porter resembled a philosopher more than a greyhound did a mastiff. Wage differences then depended on the disutilities of different kinds of labor, including the differential riskiness of income. This is fair enough and insightful. But, if taken seriously, it implies that individuals are indifferent among occupations, with wages compensating for other differences. While there is no logical problem, the contradiction to the most obvious evidence is too blatant even for a rough approximation.

I have not carried out a scientific survey of the uses of the rationality hypothesis in particular applications. But I have read enough to be convinced that its apparent force only comes from the addition of supplementary hypotheses. Homogeneity across individual agents is not the only auxiliary assumption, though it is the deepest. Many assumptions of separability are frequently added. Indeed, it has become a working methodology to start with very strong assumptions of additivity and separability, together with a very short list of relevant variables, to add others only as the original hypotheses are shown to be inadequate, and to stop when some kind of satisfactory fit is obtained.

A failure of the model is attributed to a hitherto overlooked benefit or cost. From a statistical viewpoint, this stopping rule has obvious biases. I was taught as a graduate student that data mining was a major crime; morality has changed here as elsewhere in society, but I am not persuaded that all these changes are for the better.

The lesson is that the rationality hypothesis is by itself weak. To make it useful, the researcher is tempted into some strong assumptions. In particular, the homogeneity assumption seems to me to be especially dangerous. It denies the fundamental assumption of the economy, that it is built on gains from trading arising from individual differences. Further, it takes attention away from a very important aspect of the economy, namely, the effects of the distribution of income and of other individual characteristics on the workings of the economy. To take a major example, virtually all of the literature on savings behavior based on aggregate data assumes homogeneity. Yet there have been repeated studies that suggest that savings is not proportional to income, from which it would follow that distributional considerations matter. (In general, as data have improved, it has become increasingly difficult to find any simple rationally based model that will explain savings, wealth, and bequest data.)

The history of economic thought shows some other examples and difficulties with the application of the rationality hypothesis. Smith and the later classicists make repeated but unelaborated references to risk as a component in wage differences and in the rate of return on capital (e.g., Mill 1909, pp. 385, 406, 407, 409). The English marginalists were aware of Bernoulli's expected-utility theory of behavior under uncertainty (probably from Todhunter's *History of the Theory of Probability*) but used it only in a qualitative and gingerly way (Jevons 1965, pp. 159–60; Marshall 1948, pp. 842–43). It was really not until the last 30 years that it has been used systematically as an economic explanation, and indeed its use coincided with the first experimental evidence against it (see Allais 1979). The expected-utility hypothesis is an interesting transition to the theme of Section III. It is in fact a stronger hypothesis than mere maximization. As such it is more easily tested, and it leads to stronger and more interesting conclusions. So much, however, has already been written about this area that I will not pursue it further here.

III. Rationality, Knowledge, and Market Power

It is noteworthy that the everyday usage of the term "rationality" does not correspond to the economist's definition as transitivity and completeness, that is, maximization of something. The common understanding is instead the complete exploitation of information, sound reasoning, and so forth. This theme has been systematically explored

in economic analysis, theoretical and empirical, only in the last 35 years or so. An important but neglected predecessor was Holbrook Working's random-walk theory of fluctuations in commodity futures and securities prices (1953). It was based on the hypothesis that individuals would make rational inferences from data and act on them; specifically, predictability of future asset prices would be uncovered and used as a basis for current demands, which would alter current prices until the opportunity for gain was wiped out.

Actually, the classical view had much to say about the role of knowledge, but in a very specific way. It emphasized how a complete price system would require individuals to know very little about the economy other than their own private domain of production and consumption. The profoundest observation of Smith was that the system works behind the backs of the participants; the directing "hand" is "invisible." Implicitly, the acquisition of knowledge was taken to be costly.

Even in a competitive world, the individual agent has to know all (or at least a great many) prices and then perform an optimization based on that knowledge. All knowledge is costly, even the knowledge of prices. Search theory, following Stigler (1961), recognized this problem. But search theory cannot easily be reconciled with equilibrium or even with individual rationality by price setters, for identically situated sellers should set identical prices, in which case there is nothing to search for.

The knowledge requirements of the decision maker change radically under monopoly or other forms of imperfect competition. Consider the simplest case, pure monopoly in a one-commodity partial equilibrium model, as originally studied by Cournot in 1838 (1927). The firm has to know not only prices but a demand curve. Whatever definition is given to complexity of knowledge, a demand curve is more complex than a price. It involves knowing about the behavior of others. Measuring a demand curve is usually thought of as a job for an econometrician. We have the curious situation that scientific analysis imputes scientific behavior to its subjects. This need not be a contradiction, but it does seem to lead to an infinite regress.

From a general equilibrium point of view, the difficulties are compounded. The demand curve relevant to the monopolist must be understood mutatis mutandis, not ceteris paribus. A change in the monopolist's price will in general cause a shift in the purchaser's demands for other goods and therefore in the prices of those commodities. These price changes will in turn by more than one channel affect the demand for the monopolist's produce and possibly also the factor prices that the monopolist pays. The monopolist, even in the simple case where there is just one in the entire economy, has to understand all these repercussions. In short, the monopolist has to have a full general equilibrium model of the economy.

The informational and computational demands become much stronger in the case of oligopoly or any other system of economic relations where at least some agents have power against each other. There is a qualitatively new aspect to the nature of knowledge, since each agent is assuming the *rationality* of other agents. Indeed, to construct a rationality-based theory of economic behavior, even more must be assumed, namely, that the rationality of all agents must be *common knowledge,* to use the term introduced by the philosopher David Lewis (1969). Each agent must not only know that the other agents (at least those with significant power) are rational but know that each other agent knows every other agent is rational, know that every other agent knows that every other agent is rational, and so forth (see also Aumann 1976). It is in this sense that rationality and the knowledge of rationality is a social and not only an individual phenomenon.

Oligopoly is merely the most conspicuous example. Logically, the same problem arises if there are two monopolies in different markets. From a practical viewpoint, the second case might not offer such difficulties if the links between the markets were sufficiently loose and the monopolies sufficiently small on the scale of the economy that interaction was negligible; but the interaction can never be zero and may be important. As usually presented, bargaining to reach the contract curve would, in the simplest case, require common knowledge of the bargainer's preferences and production functions. It should be obvious how vastly these knowledge requirements exceed those required for the price system. The classic economists were quite right in emphasizing the importance of limited knowledge. If every agent has a complete model of the economy, the hand running the economy is very visible indeed.

Indeed, under these knowledge conditions, the superiority of the market over centralized planning disappears. Each individual agent is in effect using as much information as would be required for a central planner. This argument shows the severe limitations in the argument that property rights suffice for social rationality even in the absence of a competitive system (Coase 1960).

One can, as many writers have, discuss bargaining when individuals have limited knowledge of each other's utilities (similarly, we can have oligopoly theory with limited knowledge of the cost functions of others [see, e.g., Arrow 1979]). Oddly enough, it is not clear that limited knowledge means a smaller quantity of information than complete knowledge, and optimization under limited knowledge is certainly computationally more difficult. If individuals have private information, the others form some kind of conjecture about it. These conjectures must be common knowledge for there to be a rationality-based hypothesis. This seems to have as much informational content and be as unlikely as knowing the private information. Further, the optimization

problem for each individual based on conjectures (in a rational world, these are probability distributions) on the private information of others is clearly a more difficult and therefore computationally more demanding problem than optimization when there is no private information.

IV. Rational Knowledge and Incomplete Markets

It may be supposed from the foregoing that informational demands are much less in a competitive world. But now I want to exemplify the theme that perfect, not merely pure, competition is needed for that conclusion and that perfection is a stronger criterion than Chamberlin perhaps intended. A complete general equilibrium system, as in Debreu (1959), requires markets for all contingencies in all future periods. Such a system could not exist. First, the number of prices would be so great that search would become an insuperable obstacle; that is, the value of knowing prices of less consequence, those on events remote in time or of low probability, would be less than the cost so that these markets could not come into being. Second, markets conditional on privately observed events cannot exist by definition.

In any case, we certainly know that many—in fact, most—markets do not exist. When a market does not exist, there is a gap in the information relevant to an individual's decision, and it must be filled by some kind of conjecture, just as in the case of market power. Indeed, there turn out to be strong analogies between market power and incomplete markets, though they seem to be very different phenomena.

Let me illustrate with the rational expectations equilibrium. Because of intertemporal relations in consumption and production, decisions made today have consequences that are anticipated. Marshall (1948, bk. 5, chs. 3–5) was perhaps the first economist to take this issue seriously. He introduced for this purpose the vague and muddled concepts of the short and long runs, but at least he recognized the difficulties involved, namely, that some of the relevant terms of trade are not observable on the market. (Almost all other accounts implicitly or explicitly assumed a stationary state, in which case the relative prices in the future and between present and future are in effect current information. Walras [1954, lessons 23–25] claimed to treat a progressive state with net capital accumulation, but he wound up unwittingly in a contradiction, as John Eatwell has observed in an unpublished dissertation. Walras's arguments can only be rescued by assuming a stationary state.) Marshall in effect made current decisions, including investment and savings, depend on expectations of the future. But the expectations were not completely arbitrary; in the absence of disturbances, they would converge to correct values. Hicks (1946, chs. 9–10) made the dependence of current decisions on expectations more explicit, but he had less to say about their ultimate agreement with reality.

As has already been remarked, the full competitive model of general equilibrium includes markets for all future goods and, to take care of uncertainty, for all future contingencies. Not all of these markets exist. The new theoretical paradigm of rational expectations holds that each individual forms expectations of the future on the basis of a correct model of the economy, in fact, the same model that the econometrician is using. In a competitive market-clearing world, the individual agent needs expectations of prices only, not of quantities. For a convenient compendium of the basic literature on rational expectations, see Lucas and Sargent (1981). Since the world is uncertain, the expectations take the form of probability distributions, and each agent's expectations are conditional on the information available to him or her.

As can be seen, the knowledge situation is much the same as with market power. Each agent has to have a model of the entire economy to preserve rationality. The cost of knowledge, so emphasized by the defenders of the price system as against centralized planning, has disappeared; each agent is engaged in very extensive information gathering and data processing.

Rational expectations theory is a stochastic form of perfect foresight. Not only the feasibility but even the logical consistency of this hypothesis was attacked long ago by Morgenstern (1935). Similarly, the sociologist Robert K. Merton (1957) argued that forecasts could be self-denying or self-fulfilling; that is, the existence of the forecast would alter behavior so as to cause the forecast to be false (or possibly to make an otherwise false forecast true). The logical problems were addressed by Grunberg and Modigliani (1954) and by Simon (1957, ch. 5). They argued that, in Merton's terms, there always existed a self-fulfilling prophecy. If behavior varied continuously with forecasts and the future realization were a continuous function of behavior, there would exist a forecast that would cause itself to become true. From this argument, it would appear that the possibility of rational expectations cannot be denied. But they require not only extensive first-order knowledge but also common knowledge, since predictions of the future depend on other individuals' predictions of the future. In addition to the information requirements, it must be observed that the computation of fixed points is intrinsically more complex than optimizing.

Consider now the signaling equilibrium originally studied by Spence (1974). We have large numbers of employers and workers with free entry. There is no market power as usually understood. The ability of each worker is private information, known to the worker but not to the employer. Each worker can acquire education, which is publicly observable. However, the cost of acquiring the education is an increasing function of ability. It appears natural to study a competitive equilibrium. This takes the form of a wage for each educational level, taken as given by both employers and workers. The worker, seeing how wages

vary with education, chooses the optimal level of education. The employers' optimization leads to an "informational equilibrium" condition, namely, that employers learn the average productivity of workers with a given educational level. What dynamic process would lead the market to learn these productivities is not clear, when employers are assumed unable to observe the productivity of individual workers. There is more than one qualitative possibility for the nature of the equilibrium. One possibility, indeed, is that there is no education, and each worker receives the average productivity of all workers (I am assuming for simplicity that competition among employers produces a zero-profit equilibrium). Another possibility, however, is a dispersion of workers across educational levels; it will be seen that in fact workers of a given ability all choose the same educational level, so the ability of the workers could be deduced from the educational level ex post.

Attractive as this model is for certain circumstances, there are difficulties with its implementation, and at several different levels. (1) It has already been noted that the condition that, for each educational level, wages equal average productivity of workers is informationally severe. (2) Not only is the equilibrium not unique, but there is a continuum of possible equilibria. Roughly speaking, all that matters for the motivation of workers to buy education are the relative wages at different educational levels; hence, different relations between wages and education are equally self-fulfilling. As will be seen below, this phenomenon is not peculiar to this model. On the contrary, the existence of a continuum of equilibria seems to be characteristic of many models with incomplete markets, as will be seen below. Extensive nonuniqueness in this sense means that the theory has relatively little power. (3) The competitive equilibrium is fragile with respect to individual actions. That is, even though the data of the problem do not indicate any market power, at equilibrium it will frequently be possible for any firm to profit by departing from the equilibrium.

Specifically, given an equilibrium relation between wages and education, it can pay a firm to offer a different schedule and thereby make a positive profit (Riley 1979). This is not true in a competitive equilibrium with complete markets, where it would never pay a firm to offer any price or system of prices other than the market's. So far, this instability of competitive equilibrium is a property peculiar to signaling models, but it may be more general.

As remarked above, the existence of a continuum of equilibria is now understood to be a fairly common property of models of rational market behavior with incomplete information. Thus, if there were only two commodities involved and therefore only one price ratio, a continuum of equilibria would take the form of a whole interval of price ratios. This multiplicity would be nontrivial, in that each different possible equilibrium price ratio would correspond to a different real allocation.

One very interesting case has been discussed recently. Suppose that we have some uncertainty about the future. There are no contingent markets for commodities; they can be purchased on spot markets after the uncertainty is resolved. However, there is a set of financial contingent securities, that is, insurance policies that pay off in money for each contingency. Purchasing power can therefore be reallocated across states of the world. If there are as many independent contingent securities as possible states of the world, the equilibrium is the same as the competitive equilibrium with complete markets, as already noted in Arrow (1953). Suppose there are fewer securities than states of the world. Then some recent and partly still unpublished literature (Duffie 1985; Werner 1985; Geanakoplos and Mas-Colell 1986) shows that the prices of the securities are arbitrary (the spot prices for commodities adjust accordingly). This is not just a numeraire problem; the corresponding set of equilibrium real allocations has a dimensionality equal to the number of states of nature.

A related model with a similar conclusion of a continuum of equilibria is the concept of "sunspot" equilibria (Cass and Shell 1983). Suppose there is some uncertainty about an event that has in fact no impact on any of the data of the economy. Suppose there is a market for a complete set of commodity contracts contingent on the possible outcomes of the event, and later there are spot markets. However, some of those who will participate in the spot markets cannot participate in the contingent commodity markets, perhaps because they have not yet been born. Then there is a continuum of equilibria. One is indeed the equilibrium based on "fundamentals," in which the contingencies are ignored. But there are other equilibria that do depend on the contingency that becomes relevant merely because everyone believes it is relevant. The sunspot equilibria illustrate that Merton's insight was at least partially valid; we can have situations where social truth is essentially a matter of convention, not of underlying realities.

V. The Economic Role of Informational Differences

Let me mention briefly still another and counterintuitive implication of thoroughgoing rationality. As I noted earlier, identical individuals do not trade. Models of the securities markets based on homogeneity of individuals would imply zero trade; all changes in information are reflected in price changes that just induce each trader to continue holding the same portfolio. It is a natural hypothesis that one cause of trading is difference of information. If I learn something that affects the price of a stock and others do not, it seems reasonable to postulate that I will have an opportunity to buy or sell it for profit.

A little thought reveals that, if the rationality of all parties is common knowledge, this cannot occur. A sale of existing securities is simply a

complicated bet, that is, a zero-sum transaction (between individuals who are identical apart from information). If both are risk averters, they would certainly never bet or, more generally, buy or sell securities to each other if they had the same information. If they have different information, each one will consider that the other has some information that he or she does not possess. An offer to buy or sell itself conveys information. The offer itself says that the offerer is expecting an advantage to himself or herself and therefore a loss to the other party, at least as calculated on the offerer's information. If this analysis is somewhat refined, it is easy to see that no transaction will in fact take place, though there will be some transfer of information as a result of the offer and rejection. The price will adjust to reflect the information of all parties, though not necessarily all the information.

Candidly, this outcome seems most unlikely. It leaves as explanation for trade in securities and commodity futures only the heterogeneity of the participants in matters other than information. However, the respects in which individuals differ change relatively slowly, and the large volume of rapid turnover can hardly be explained on this basis. More generally, the role of speculators and the volume of resources expended on informational services seem to require a subjective belief, at least, that buying and selling are based on changes in information.

VI. Some Concluding Remarks

The main implication of this extensive examination of the use of the rationality concept in economic analysis is the extremely severe strain on information-gathering and computing abilities. Behavior of this kind is incompatible with the limits of the human being, even augmented with artificial aids (which, so far, seem to have had a trivial effect on productivity and the efficiency of decision making). Obviously, I am accepting the insight of Herbert Simon (1957, chs. 14, 15), on the importance of recognizing that rationality is bounded. I am simply trying to illustrate that many of the customary defenses that economists use to argue, in effect, that decision problems are relatively simple break down as soon as market power and the incompleteness of markets are recognized.

But a few more lessons turned up. For one thing, the combination of rationality, incomplete markets, and equilibrium in many cases leads to very weak conclusions, in the sense that there are whole continua of equilibria. This, incidentally, is a conclusion that is being found increasingly in the analysis of games with structures extended over time; games are just another example of social interaction, so the common element is not surprising. The implications of this result are not clear. On the one hand, it may be that recognizing the limits on rationality

will reduce the number of equilibria. On the other hand, the problem may lie in the concept of equilibrium.

Rationality also seems capable of leading to conclusions flatly contrary to observation. I have cited the implication that there can be no securities transactions due to differences of information. Other similar propositions can be advanced, including the well-known proposition that there cannot be any money lying in the street, because someone else would have picked it up already.

The next step in analysis, I would conjecture, is a more consistent assumption of computability in the formulation of economic hypotheses. This is likely to have its own difficulties because, of course, not everything is computable, and there will be in this sense an inherently unpredictable element in rational behavior. Some will be glad of such a conclusion.

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