

Knowledge in economics: game-theoretic vs market-process

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CRISTINA BICCHIERI, *Rationality and Coordination*, New York; Cambridge University Press 1993, pp. xiii + 270

ESTEBAN F. THOMSEN, *Prices and Knowledge: A Market-Process Perspective*, London; Routledge 1992, pp. vii + 150

How knowledge is recognized in economic theory appears to be a hot topic in current research despite its methodological nature. It would seem that finally researchers have abandoned the simplistic notion that neoclassical economics requires some sort of perfect knowledge to be presumed on the part of every decision maker. Few neoclassical economists today would ever agree that perfect knowledge is a requirement, even for the attainment of an equilibrium.

Friedrich Hayek was probably the first economic theorist to argue that consideration of knowledge recognition is an essential element in any economic theory. Interestingly, Hayek made two different arguments concerning knowledge in economic theory. In his 1937 article "Economics and knowledge" he said that any explanation of an individual's decision requires an explanation or assumption concerning how that individual "acquired" the needed knowledge. In his 1945 article "The use of knowledge in society" he presented a view that markets should be considered the primary source of knowledge about the economy by observing the disequilibrium behaviour of prices. In particular, Hayek argues, it is the process of moving toward an equilibrium rather than the attainment of the state of equilibrium that constitutes the only possible useful information one can obtain from a market.

These two articles lead to two different research programmes, one purely theoretical and the other purely ideological. That is, while the 1937 article is a challenge to equilibrium theorists, the 1945 article is part of a polemic struggle with "socialists" and other central planners. The 1945 article advocates a market system since such a system necessarily provides the knowledge needed to induce decision makers to do the right thing with respect to the aggregate interests of society. If people want more of good A and less of B, a rising price for A and falling price for B is sufficient knowledge to induce the increased production of A and the reduced production of B. Presumably, a rising price communicates a rising profit to the producers of A. Of course, this is only because it is presumed that the market started in long-run equilibrium and, more importantly, that the market is inherently stable.

Both of Hayek's arguments present interesting theoretical problems. In considering the methodological questions that must be addressed by any attempt to deal with these problems, I decided to examine some recently published books about knowledge in economics. Today, those researchers interested in the challenge of Hayek's 1937 article will most likely be engaged in some sort of game-theoretic analysis. I found Cristina Bicchieri's 1993 book to be an excellent example of such a study. Among those researchers more interested in belabouring the presumed failure of neoclassical equilibrium-based economics and thereby arguing in favour of a market-process perspective will be those who promote Austrian economics in general and Hayek's 1945 paper in particular. In this case, I found Esteban Thomsen's book to be a clear example of such a promotion. As I will explain, while Bicchieri's book goes a long way toward addressing the problem of including explicit knowledge assumptions in economics models, Thomsen's book seems to fail to provide a clear understanding of the problem at hand. In one key respect, he adopts a contradictory position as I will explain below.

There are very few books published in economics that are about the knowledge assumptions used in economic theory. Most mainstream economic model builders today do not want to waste their time considering any such methodological difficulties. Instead, they will simply assume that all knowledge and learning is captured in a routine application of Bayesian decision theory. According to this decision theory, decision makers first form "prior" assessments involving probability functions over conceivable propositions about the nature of the world. Second, the decision makers adjust their assessments as new observations are made or reported about the nature of the world. The adjustment is conditional on the nature of the observations including that the new observations be minimally consistent with the prior

assessment. This Bayesian approach is thought to capture both the nature of knowledge (namely, one's priors) and the nature of learning (namely, the adjustment of one's prior assessment). The Bayesian decision theory seems to be limited to the same situation that George Stigler presumed in his famous 1961 article "The economics of information": More information means better probability assessments such that if one had all the information the probability assessment would converge to 1. But, as Stigler notes, such perfection of knowledge would be too expensive. So, at any point of real time, knowledge is always imperfect. Bayesian decision theory does not seem to add anything more than some formalism in terms of probability logic.

To some of us, Bayesian decision theory is at best crude and at worst incapable of dealing with refuting observations. As some of us have learned from Karl Popper, only refuting evidence is informative. Moreover, no matter how much confirming evidence one has to date, the next observation can falsify all or part of our assumed knowledge. How does the individual respond to refuting evidence? Is there a "rational" way to respond? If so, can we expect to be able to predict the individual's response.

An obvious way to answer these questions is to delve into game theory. At its most fundamental aspect, game theory is about modeling social interaction between "rational" individuals. Any interaction presupposes that the players form expectations of what the other players will do as well as what the others know or expect. The easiest analysis takes place when the players have a clear understanding of the logic of the game's situation (all the possible moves and payoffs) and where that game has clear and compatible options for all players.

Bicchieri recommends that we begin any consideration of game theory by recognizing two types of rationality: practical and epistemic. Practical rationality is what forms the foundation of neoclassical economics, namely, constrained optimization by individuals. Epistemic rationality refers to beliefs that can be rationally justified. And what is consistently argued throughout her book is that epistemic rationality is a process, namely, how one goes about using available data and information about the environment that defines the constraints recognized in practical rationality. In game theory the constraints involve not only the rules of the game but the practical and epistemic rationality of the other players.

The standard solution to game situations that cannot rely on external assurances of cooperation or compatibility is the so-called Nash equilibrium. Specifically, a Nash equilibrium is a set of options and knowledge that allows each individual to optimize given his or her knowledge about the other players' options. Typically, people who simply apply game theory to economic explanatory problems design their game so that there is one possible Nash equilibrium. They then focus all of their attention on the analytical nature of that equilibrium. What justification is there for focusing only on the Nash equilibrium? To answer these questions, some game theorists see their job as identifying the necessary conditions that must be placed on games that will assure the attainment of a Nash equilibrium. As Bicchieri [p. 58] observes,

Game theorists typically assign predictive value to Nash equilibrium; the best available explanation of the achievement of a Nash equilibrium in a given case is that each of the players knows what the other players are going to do. It is for this reason that theorists who predict that a Nash equilibrium will be achieved also assume that players know what the other players will do. But notice that knowledge of what others will do is not implied by the definition of a Nash equilibrium. Therefore, one wishing to explain the occurrence of a Nash equilibrium does well to explain how those correct beliefs are arrived at in the first place.

The Nash equilibrium is, in effect, the game-theoretic analogue of a market equilibrium where, by definition of demand and supply curves (namely, the two loci of price-quantity points where respectively all demanders and all suppliers are individually maximizing), equality of demand and supply implies universal maximization at the equilibrium price. If everyone could calculate the equilibrium prices in advance, then everyone would simply demand the equilibrium quantity or supply the equilibrium quantity (and thus the market equilibrium quantity is just the sum of what all demanders want or all suppliers provide). In this sense, equilibrium prices and quantities are also predictable whenever we can know all that we would have to know.

To the extent that the use of a Nash equilibrium is analogous to the neoclassical economists use of the attainment of a market equilibrium, it would seem that Hayek's 1945 argument would be a viable alternative. The entire point of Hayek's argument is that no central planner or Walrasian auctioneer could ever know all that needs to be known to be able to calculate the equilibrium price. The virtue of the market

process is not the attainment of the equilibrium but the fact that whenever the market is not in equilibrium, sufficient information is provided by the market to get it to move toward the equilibrium. But Hayek's argument is just as presumptive as the commonplace requirement of a Nash equilibrium for a successful prediction. It should be asked, how do we know that the changes in the disequilibrium prices will move toward the equilibrium? Unless we have reasons for why the market is inherently stable (e.g., supply curves are always upward sloping and demand curves are always downward sloping), there is no guarantee that the price is moving in the right direction.

It is interesting that Thomsen [pp. 8-11] quotes Franklin Fisher [1983] to support a contention that economists now think that market equilibrium should be abandoned in favour of a disequilibrium-based analysis. Thomsen is mistaken since Fisher is arguing for just the opposite, namely, a richer view of equilibrium that would explain away potential disequilibria. Specifically, Fisher is recognizing the *problem of stability*. If one is going to use equilibrium models to predict or explain behaviour, one must also explain why that equilibrium would, or could, ever be reached. At minimum, that equilibrium must be stable and that stability must be behaviourally systematic. Fisher attempted to solve this problem of stability by recognizing that any equilibrium analysis must model how the individual decision maker becomes aware of the existence of any disequilibrium.

This misunderstanding of stability analysis continues later on in his book when discussing Richard Nelson's view that general equilibrium theorists have failed to prove stability. Thomsen [p. 102] says "Nelson ... assigns too much importance to the very limited results obtained by stability analysis". But as I have said above, assurances of stability are essential if one is to put so much faith in Hayek's 1945 argument. With his criticism of Nelson, Thomsen seems not to appreciate that the failure to solve the stability problem means that Hayek's 1945 argument is at worst irrelevant and at best incomplete.

Bicchieri is definitely not assigning too much importance to the problem of explaining the attainment of Nash equilibrium and by implication of any general equilibrium. Consider, for example, matters of macroeconomic policy which to be effective must anticipate how people will react. Bicchieri [p. 30] notes that "To achieve a predictive theory of the sort needed for macroeconomic policy, one needs a theory of how agents learn, which would allow the theorist to predict which equilibrium the economy converges to after a policy change". In the 1970s and 1980s such questions were discussed in terms of so-called "rational expectations". Typically, when building macroeconomic models, it was assumed that every economic agent formed rational expectations in the manner (critics charge) of expert econometricians. While perfect information was not assumed, all agents still reached compatible views of the economy within the acceptable limits of stochastic estimations. One view of such expert econometrics is that the decision maker is choosing one of many possible models of the economy based on the same data available to every other decision maker. Bicchieri sees this as agents "engaged in a game of model choice, where a successful model is just one that is consistent with the models upheld by other agents". And she notes that "a successful model is a self-fulfilling model" [p. 31]. Moreover, any self-fulfilling equilibrium is a Nash equilibrium.

Apart from being a very good introduction for people who are not yet up to speed in the use of game theory to analyze economic explanations, Bicchieri's book provides some interesting criticisms of what it would take to use game theory to analyze economic problems. Even the static normal form of a game where players make their moves simultaneously can have problems. The players can independently analyze the game prior to making their moves, but "in many nontrivial cases, knowledge of the game being played and self-evident principles of rationality are not sufficient to guarantee that an equilibrium will be attained" [p. 33]. Moreover, assuming that the players have the necessarily correct beliefs about the other players rational choices "is tantamount to assuming what has to be explained" [ibid.]. How do we assure that the players will do the right thing? One way to get around the insufficiency is to always put the game into a social context where, external to the game, society provides norms to assure that the players are guided to a cooperative equilibrium. But, again that would be assuming something that we are supposedly explaining.

The (static) normal form of the game does not directly lead to considerations of the process of learning what one needs to know to make an equilibrium move unless we are looking only at repeated games. Alternatively, we could adopt a more general view where the game is played by players making alternating moves such as in checkers or chess. This so-called extensive form of games opens the opportunity to consider how the players learn to make the right move without begging the question by presuming their knowledge is a priori correct.

Bicchieri discusses various tactics used to “solve” extensive games such as so-called backward induction (which has nothing to do with the notion of induction discussed by philosophers but instead is a form of mathematical induction). Interestingly, she shows that to obtain the backward induction solution requires that the players not have too much knowledge a priori. Thus to make a move a player has to form an expectation of what the opponent will play. What should be the player’s move after the opponent makes an unexpected move? If the opponent makes an unexpected move should the player revise his or her knowledge of the game in light of the refuted expectation? If so, how? Is there a rational way to adjust one’s knowledge? If so, perhaps there is a way to assure the attainment of an equilibrium even in games without a priori complete knowledge. One obvious way would allow all players to know how everybody learns or adjusts their knowledge (rational beliefs).

In a world or game where everyone begins with incomplete knowledge, assuming everyone nevertheless has complete knowledge with regard to how people learn seems at best arbitrary or at worst heroic. Bicchieri wants to find a better way. Ultimately, she attempts to offer an explanation of external social environments which provide the social norms to assure that the equilibrium moves will be played without assuming that the players have complete knowledge. That is, players can overcome incomplete personal knowledge by utilizing the objective information supplied by social norms. Social norms, like all social institutions, embody social knowledge (see Arrow 1994). However, if we are to rely on knowledge that is external to the game, then Bicchieri thinks we need to explain how such social norms came to exist. She thinks some form of rational evolutionary mechanism needs to be included if we wish to explain the attainment of the equilibrium. Specifically, she argues [p. 222]

social norms are clusters of self-fulfilling expectations. To explain how norms arise therefore requires explaining how expectations become self-fulfilling.... For social norms to be Nash equilibria, agents’ beliefs about other agents’ beliefs and behavior must also be correct, in that they coincide with the other agents’ actual behavior (and beliefs that support that behavior). That is why it is important to develop a theory of learning in games, a theory that would explain how a player’s beliefs about the environment ... evolve until they have come to agree with the actual properties of the environment. This “agreement” means that players’ expectations are stable ... and correct. It is usually the case that a norm of behavior is not followed by just a small group of people. Many norms are followed by large populations for a long period of time, and this fact raises the further question of how a norm can emerge, spread to, and persist in an entire population. The thesis I shall propose is that norms emerge in small-group interactions and may subsequently spread to an entire population through an evolutionary mechanism.

Bicchieri provides two conditions to define a social norm in a given population: (1) almost every member of the population prefers to conform to the social norm *on the condition* that almost everyone else conforms, too; and (2) almost every member of the population believes that almost every other member of the population conforms to the social norm. However, she notes that [p. 235]

Conditions (1) and (2) reconcile norms with strategic behavior, but at a price: Characterizing social norms as equilibria spells out the conditions under which norms can be upheld, but it does not indicate how these conditions can be realized. Since social norms are standards of behavior that have come to be expected by a community in a particular setting, to describe how expectations arise and become self-fulfilling is part of an explanation of how norms emerge.

Bicchieri’s strategy to deal with emergence is to assume as a first step that small groups can easily learn to cooperate and thus she claims that [p. 253]

The emergence of norms is an example of spontaneous order, a form of coordination that takes place without the intervention of a central authority and does not presuppose previous agreements or “contracts” among the parties. Yet social norms embody some form of rationality and are ultimately reducible to individual preferences and beliefs. In this sense, the emergence of social norms can be studied in the context of noncooperative games, in which by definition no binding agreements are possible. We know that, in such games,

whenever an agreement or some other form of coordination is reached, that agreement must necessarily be a Nash equilibrium. Thus, we have equated the emergence of a norm with the attainment of a Nash equilibrium.

A crucial feature of social norms is that they involve conditional preferences, and thus the type of games adopted to model their emergence must exclude games with dominant strategies... [A]ll games devoid of dominant strategies present the problem of justifying the use of Nash equilibrium as a good prediction of how the game will be played. In such games, either one assumes that player's expectations are common knowledge or else a plausible story is needed that tells how players' expectations are formed and come to agree.

Ultimately, the minimum condition for any plausible story is that it must explain how, for example, "players who interact with each other for a long period of time and do not have common knowledge of rationality or common priors come to 'settle' onto a stable pattern of play" [p. 255].

While I think Bicchieri is on the right track by recognizing that ultimately, all explanations of social behaviour in the context of methodological individualism (only individuals make decisions, things cannot decide) must address the problem of stability, the path she has chosen is doomed for two reasons. First, relying on "spontaneous order" seems to be assuming what she is trying to explain. And second, her two conditions, (1) and (2) above, do not go far enough to limit the notion of a social norm. I think that a minimum condition is that the "social norms", like all social institutions, must solve (or be seen to solve) some agreed upon social problem. Thus, the persistence of a social norm (or any social institution) can be minimally explained by the fact that it solves a problem (for more on this approach to institutions and norms, see my 1979 article and Chapters 7 and 8 of my 1992 book). Moreover, where the idea of the solution comes from is not important since our explanations are always after the fact of there being a shared problem. I think the problem-solution approach provides a needed reason for the persistence of an institution or norm.

I find it interesting that in the end, Bicchieri faces the problem of stability that I have said the followers of Hayek's 1945 article eagerly wish to ignore. The problem of stability seems to hang around like a skeleton in the closet. While the problem of stability was recognized earlier in the works of Ragnar Frish and Paul Samuelson, it became a more common issue after Kenneth Arrow published his 1959 article "Towards a theory of price adjustment". As Arrow notes, our theories of demand and supply are based on the notion of a maximizing price-taker such that if everyone were facing the market-clearing price then everyone would be successfully maximizing. If the price were for some reason higher (and demand curves slope downward while supply curves slope upward) then the utility maximizing demand will fall short of the quantity that is provided to the market by all of the suppliers who intend to maximize their profits. While some individual suppliers will be able to sell the quantity they need in order to maximize, others will fail. What do those who fail do in order to maximize? Our textbooks simply say the price will fall. But, who lowers the price and by how much? To be consistent, a neoclassical economist must explain the price adjustment as a maximizing decision.

Arrow suggests that the textbook theory of the imperfect competitor has a profit maximizing reason for setting the price (viz, by choosing the point of the demand curve it faces where its marginal revenue equals its marginal cost and thus the point where profit is maximized). Unfortunately, this suggestion leaves us with two incompatible theories: one for equilibrium and a different one for disequilibrium. But even if we allow this, there remains a problem with the explanation of the price adjuster. Specifically, how does the firm know its demand curve in order to calculate its marginal revenue? As Robert Clower has shown in his 1959 article "The ignorant monopolist", if the firm cannot know a priori its demand curve, then it must make assumptions in order to conjecture about its marginal revenue. He shows that even when the needed assumptions are in fact wrong, the firm may still reach a point where the market clears such that the firm thinks it is maximizing its profit. Unless the firm's conjectured marginal revenue curve is correct, the "equilibrium" price reached is unpredictable except when we know the assumption made by the monopolist (for more, see Boland 1997, Chapter 14).

One reason Bicchieri thinks there is a need for endogenously provided social norms is that once one recognizes imperfect or bounded knowledge, the Nash equilibrium fails to be predictable. In a sense, the Arrow-Clower situation is the same one being addressed by Bicchieri except it is without all the trappings of game theory.

Fisher's [1983] approach to the problem of stability is to insist that our explanation of the market include something about "disequilibrium awareness". Obviously, before we can predict how the decision makers respond to a disequilibrium we need to explain how the decision makers become aware of the disequilibrium. Nevertheless, it is doubtful that there will ever be a neoclassical explanation that can provide the needed theory of price adjustment without addressing how decision makers learn what they need to know. So far, if Bicchieri is correct, not much has been accomplished even with the help of game theory.

We might wonder why so little has been accomplished toward modeling the knowledge and learning aspects of neoclassical explanations of prices and markets. For some time my view has been that the source of the difficulties is the common presumption that knowledge is quantifiable or something to be "acquired". While knowledge of languages might be thought of as a quantifiable form of knowledge, such "know-how" is not the knowledge recognized in decision making. To be able to deal with the type of knowledge recognized in the explanation of decision making, I have been recommending that we should give up assuming that knowledge is like wealth, something we can have more of, and instead we should adopt the view that knowledge is like health, something we can improve.

The health-like view of knowledge is as least as old as Socratic dialogues. According to this view, learning always begins with discovering an error in one's understanding. The source of one's prior knowledge (the knowledge that one is correcting) is usually irrelevant.

The first step to adopting this health-like view of knowledge is to avoid any heavy reliance on Bayesian learning since this learning is both quantitatively expressed (using Bayes' theorem to revise one's priors in light of new confirming observations) and limited to non-Socratic learning (by limiting learning to marginal improvements of the confirmation of one's priors). Bicchieri goes a long way in this direction when she chooses to adopt Peter Gärdenfors' characterization of knowledge. At minimum, this view admits that knowledge (or "beliefs" as philosophers insist on saying) can be false and thus needs to be revised. Unfortunately, on closer examination it turns out that the actual learning response is made quantitative. Specifically, Bicchieri adopts Gärdenfors' "economy of information" where a learner revises his or her knowledge by assessing the informational value of his or her knowledge after accepting possibly refuting evidence (see Gärdenfors 1988, Chapter 3).

Interestingly, adopting the informational-economy approach in effect is an attempt to make the philosophical problem of knowledge evaluation an exercise in economic analysis. In a 1971 article I examined such strategies of choosing between alternative theories or models that would constitute our knowledge [see Boland 1971 and 1989, Chapter 5]. My examination simply drew an analogy between the problem of defining a welfare function for a whole society and the problem of defining a choice function to evaluate knowledge. Since we know we cannot define an adequate welfare function, I argued that it is the same with the economy of knowledge evaluation; there is no rational formula to choose the best theory or explanation.

So, what have I learned from these two books? From the Thomsen book, not much. If one understands the message in Hayek's 1945 article, there is nothing new here. However, if one is unfamiliar with Hayek's 1945 article, then there is much to learn from this book. With the Bicchieri book, there is much more to ponder. If you are unfamiliar with the intricacies of game theory, then this book is for you. While readers who are well versed in the game-theory literature may complain that some of the recent attempts to deal with the shortcomings of Nash-equilibrium-based explanation have not been recognized by Bicchieri, her arguments still need to be addressed.

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