Why Take A Game Theoretical Approach to Economics?

Institutions, Economics and Game Theory

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Abstract

This paper discusses the advantages obtained by studying economic problems from a game theoretical, as opposed to a neoclassical, perspective. It is argued that these advantages result from game theory's ability to model or represent formally a much broader class of social and economic institutions than the neoclassical theory which concentrates almost totally on one limited type of social institution -- competitive markets. Examples are given to demonstrate this point by referring both to the cooperative and non-cooperative game theoretical treatments of the problem of general competitive equilibrium.

Cet article analyse les avantages que présente la théorie des jeux par rapport à la théorie néoclassique dans l'étude de problèmes économiques. Ces avantages proviennent du fait que la théorie des jeux est à même de modeler ou de représenter de manière formelle une classe d'institutions économiques et sociales plus large que la théorie néoclassique, qui traite presque uniquement d'un seul type restreint d'institution sociale, le marché de concurrence parfaite. Les exemples présentés en illustration appliquent à la fois la théorie des jeux coopératifs et non coopératifs au problème de l'équilibre général de concurrence parfaite.
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Introduction

One question that continually arises both amongst economists interested in game theory and those skeptical of its use is: what are the advantages of looking at economic theory from a game theoretical point of view? When they say advantages what they mean, I guess, is what are the advantages of looking at economics from a game theoretical perspective as opposed to a straight neoclassical perspective. To answer this question it is first necessary to quickly look at the neoclassical theory in its most formal and rigorous version--its discussion of general equilibrium analysis and the theory of value as presented by Debreu (1959) and Arrow and Hahn (1971), and to try to point out in this analysis exactly where the theory is in need of a game theoretical reformulation.

Section I. The Neoclassical Approach to the General Equilibrium Problem

There are basically three elements to the neoclassical examination of competitive equilibrium which describe the technology and the type of firms that exists in the economy, the type of consumers that exist, and finally the type of behavior that is expected from all agents and the mechanism used to form prices given this behavior. Let us look at these parts one at a time.

First, there is not much that one can say about the neoclassical description of the agents in the economy, i.e., the description of the firms and the consumers. In the case of the firms all firms are supposed
to be individual entrepreneurs who are constrained in transforming inputs into outputs by a technology which is assumed to be represented by a production set $Y_i$ in which

(i) $Y_i$ is compact and convex,

(ii) $Y_i \cap \Omega = \{\emptyset\}$ where $\Omega$ is the non-negative orthant—"No Free Lunch"

(iii) $Y_i \cap (-Y_i) = \{\emptyset\}$—non-reversibility.

These assumptions for individual production sets yield aggregate production sets which are also compact and convex and exhibits the no free lunch and non-reversibility properties. Consumers are portrayed in a symmetric manner by specifying a consumption set $C_h$ which is assumed to be a compact convex subset of some $n$-dimensional commodity space which is completely ordered by preferences which are continuous, transitive, reflexive, and convex.

The next step in the neoclassical analysis is to describe the behavior of the agents and the mechanism by which this behavior determines prices. It is at this point that the theory starts to unravel. First of all the theory posits an objective function for the agents in which producers are supposed to maximize profits and consumers are supposed to maximize their utility. Now many critics have stopped at this point and criticized the neoclassical theory for positing unrealistic objective functions for the agents, but from a game theoretical point of view this

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1See in particular the satisficing literature initiated by Simon (1979) as well as the literature on the behavioral theory of the firm by Cyert and March (1963) and Baumol's sales maximization objective (1967).
is not where one should level any criticism. A more damaging behavioral assumption is that all agents behave as price takers and maximize the value of their objective function taking these prices as given by a *deus ex machina* known as the fictitious auctioneer. The problem with this assumption is that it closes the model by forcing a very strict institutional structure onto the problem of general competitive equilibrium because by making this price taking assumption we are explicitly assuming that perfect markets exist and that these markets transmit sufficient information to decentralize all economic activity. The problem with this assumption is not its lack of realism, because, although these fictitious auctioneers clearly do not exist, it can be said that markets do function *as if* they really did. Rather, the assumption has the following two weaknesses:

1. It robs the model of any behavioral or strategic complexity or interest. The neoclassical agents are bores who merely calculate optimal activities at fixed parametric prices. They are limited to one and only one type of behavior—that of acting as automata in response to the auctioneer. No syndicates or coalitions are formed, no cheating or lying is done, no threats are made—merely truthful parametric behavior. This strategic assumption has been called the Walras-Pareto fixation by Morgenstern (1972) and has been criticized strongly by game theorists, especially Martin Shubik (1973, 1974), whose recent work has been an attempt to close these models strategically in a non-cooperative framework of trade as opposed to the neoclassical method of the "magic wand."

2. More important for our purpose, however, the manner in which the neoclassical model is closed robs the model of any institutional sophistication. By this I mean that by positing the existence of a fictitious auctioneer, the theory is making an extreme institutional
assumption: that the only institutions that exist in the economy are markets of the competitive type and that all information in the economy must be transmitted through the prices formed in these markets. This is clearly extreme. The economy has no money, no government, no legal system, no property rights, no banks—in short, none of the many social institutions that are created by societies to help coordinate their economic and social activities by offering information not available in competitive prices.

When we realize the impact that the seemingly innocuous existence of the fictitious auctioneer has on the results of the neoclassical model, we are able to retrace our steps and investigate the assumptions necessary for the model to work. When we do this, we immediately realize that these assumptions are the minimal assumptions necessary for the institutional structure forced on the model to be sufficient for its purposes—reaching a decentralized competitive equilibrium. The relaxation of any of these assumptions immediately makes the institutional structure of neoclassical economics inadequate for its purpose. The model really works backward. Given the assumed institutional arrangement—competitive markets—it investigates the types of economic environments for which decentralized economic equilibria exist. These environments then become the focus of study for the theory. Consequently, if one were to close the model in a less restrictive manner, economics would be freed to study a wider variety of economic environments [see Hurwicz (1973a)]—economies that include nonconvexities, discontinuities, and externalities, in a much more natural way. The job of the theory would then be to explain the type of institutional arrangement that would evolve from a particular environment or to design institutions that, for any given environment, would reach "satisfactory" allocations. [For a further analysis of this point, see Hurwicz (1973a).]
In summation, what I am saying is that economics, as presented in its most formal neoclassical version, is a theory that concentrates on the derivation of price relationships given one fixed institutional structure—perfectly competitive markets. In this analysis the endogenous variables are prices and the institutional structure of the economy is fixed exogenously. But is this the really interesting question for economics to be investigating or should it be trying to explain the endogenous evolution and creation of both prices and institutions? In other words, what should be the endogenous variables which economics in particular and social science in general attempts to explain? It is my belief that as economists we must simultaneously explain both the institutional structures and the set of equilibrium value relationships that are associated with those institutional structures. Merely studying the price relationships that emerge from one particular institutional structure cannot be sufficient [See Schotter, Chapter 5 (1981), for an elaboration of this point.]

Section II: Game Theory and Institutions

But how is game theory useful in this pursuit. First of all as Schotter and Schwödiauer (1980) and Schotter (1981) point out, one can make a strong case for the claim that the original intent of Von Neumann and Morgenstern (1944) was to create a mathematical theory of social institutions. In fact the question they address themselves to in the Theory of Games and Economic Behavior is what set of institutional relationships (and associated price relationships or imputations) are likely to emerge as a stable set of relationships from some fixed situation of social interaction (be it political, economic or sociological) described as a game. To demonstrate that this was their concern we must
only look at the introduction to the Theory of Games and Economic Behavior and replace the words "orders of society" and "standards of behavior" with the words institutional relationships in the following passage:

The question whether several stable "orders of society" or "standards of behavior" based on the same physical background are possible or not, is highly controversial. There is little hope that it will be settled by the usual methods because of the enormous complexity of this problem among other reasons. But we shall give specific examples of games of three or four persons, where one game possesses several solutions in the sense of 4.5.3 [the stable-set solution]. And some of these examples will be seen to be the models for certain simple economic problems. [Von Neumann and Morgenstern (1947), p. 43.]

But to claim that game theory had such an institutional intent is quite different from claiming that it actually succeeds in presenting a viable alternative that has the flexibility to accomplish this intended purpose. Let us see how this has been attempted.

a) The Cooperative Game Theoretical Approach

The first attempt to reformulate the theory of general competitive equilibrium along cooperative game theoretical lines was made by Martin Shubik (1959) in an article in which he pointed out the relationship between Edgeworth's famous contract curve and a new game theoretical solution concept developed by Gillies (1959) and Shapley (1950). The formal relationship between these two concepts and their asymptotic relationship to the neoclassical concept of a competitive equilibrium was first demonstrated by Scarf (1962) and simplified by Debreu and Scarf (1963). [A survey of the literature on the core and competitive equilibrium was made by Schotter (1973).] To understand why this attempt could be considered an advance over the neoclassical formulation when viewed from an institutional perspective and simultaneously why it must also be
considered a failure in this endeavor let us briefly review how this analysis proceeds.

First, the cooperative game theoretical analysis of the problem of general competitive equilibrium starts in a way identical to the neoclassical analysis by describing the types of agents that exist in the economy. Here, as in the neoclassical model, firms are depicted as profit maximizing agents who transform inputs into outputs through a technology depicted as a production set which is compact, convex, and has the non-reversibility and "no-free lunch" properties while consumers are depicted as utility maximizing agents who choose commodity bundles from a compact convex consumption set. Hence up to this point the models are identical. They diverge, however, when the cooperative game theoretical model describes the behavior of the agents and the process by which prices are formed since it is not assumed here that either firms or consumers are price takers. Rather they are assumed to have the behavioral flexibility to form coalitions and bargain among themselves as to how they are going to split up the goods available to them in their coalition. By making this assumption the game theoretical analysis does take a big institutional step forward because it does not assume at the outset that competitive markets exist but rather leaves the equilibrium institutional structure that will emerge from the multilateral bargaining as an endogenous variable which along with prices has to be solved for at the equilibrium. As such, the cooperative game theoretical analysis of the problem of general competitive equilibrium seemed to offer great hopes for a more institutionally flexible analysis of price and formation. It presented a model that was a priori institutionally neutral and one that did not force all economic activity through competitive markets and also had at
its disposal a wide variety of "positive" solution concepts which could be applied to the model [i.e., the core, the Von Neumann Morgenstern (stable set) solution (Von Neumann and Morgenstern 1944), \( \Psi \)-stability (Luce 1955), the Aumann and Maschler bargaining sets (1964), the Kernel, (Davis and Maschler (1965))] to analyze its equilibrium as well as some normative concepts such as the Shapley value (Shapley (1953)) and the nucleolus [Schmeidler (1969)].

To demonstrate how such an approach contrasts to the neoclassical approach to the process of price formation consider a simple partial equilibrium analysis of a market in which there is one seller who has 2 units of a good to sell and three buyers all of whom want to buy one unit. Further assume that the seller will sell any unit for a price of 60¢ or more while each buyer is willing to buy any unit for a price up to but not exceeding 90¢. With the information the conventional analysis of price formation would proceed by constructing the appropriate supply and demand curves and solving for that price at which supply equals demand. This would appear as follows:

![Diagram](image)

Hence, in the neoclassical analysis the question asked is: What price or value relationships are consistent with the hypothesized institutional structure of perfect markets? The emphasis is on values given institutions.
Consequently, since the buyers' side of the market is the long side, the price is supposedly bid up to the buyers' reservation price yielding an imputation in which the seller receives 30¢ profit on each unit sold while the buyers' consumer surplus is reduced to zero or an imputation \( x = (60,0,0,0) \). The market price 90¢ is associated with this imputation and if one accepts the analysis as valid one sees an equilibrium institution-price relationship established.

But is this really the relevant question? In other words, is the relevant question what equilibrium price is consistent with the assumption that perfect markets exist or should we, as social scientists and economists, be asking ourselves which equilibrium institution-price pair will emerge as the stable pair or set of pairs in this situation of strategic and social interdependence. If it turns out that the only stable institution-price pair is the competitive market-competitive price pair (which, by the way, is a feature of the Lucas (1968) counter-example demonstrating the non-existence of a stable set solution to a 10-person game which Shapley and Shubik (1969) demonstrate to be a market game) then we can say that the neoclassical analysis is not institutionally myopic in its assumptions. But if other institutions other than competitive markets might emerge and define different equilibrium value relationships which may involve a set of personalized (hence not competitive) prices, then the neoclassical approach is myopic in not being able to define these equilibrium institutions and their associated pairs as logical possibilities.

To make this point more precise let us look at the cooperative game theoretical analysis of the exchange situation described above. To do this we must define the characteristic function associated with this situation by defining the value of any coalition as the maximum sum of the consumers
and producers surplus that can be achieved by any coalition of traders. Ietting the seller have the index 1 and the buyers the indices 2, 3, and 4 and assuming transferable utilities and side payments the characteristic function appears as:

\[ V(1) = V(2) = V(3) = V(4) = 0 \]

\[ V(12) = V(13) = V(23) = V(24) = 30 , \quad V(23) = V(24) = V(34) = 0 \]

\[ V(123) = V(124) = V(134) = 60 , \quad V(234) = 0 \]

\[ V(1234) = 60 \]

Now if buyers restrict their behavior to coalition forming behavior or "blocking"-recontracting behavior, then the equilibrium imputation associated with this behavior is the unique core imputation \( x = (60,0,0;0) \) in which the seller sells both units for a price of 90c thereby extracting all of the consumer surplus from the buyers. This outcome is then identical with the outcome attained by the neoclassical market, however, and if one wanted to in this case one could say that this blocking or recontracting behavior defines a competitive market-competitive price pair as the equilibrium institution-price pair for this situation of exchange. But traders need not restrict themselves to this type of behavior. There may be other standards of behavior that lead to other stable institution-price or imputation pairs as defined by the Von Neumann-Morgenstern solution and these equilibrium institutions should not be ruled out a priori by the assumption that only markets of the competitive type exist in the economy under investigation. For instance, the buyers, realizing that blocking or re contracting will inevitably lead to the core, may form a cartel and refuse to bargain with the sellers except as a unit. If they do this then there are several equilibrium stable institution-price pairs that might emerge as Morgenstern and Schwödiauer (1976) demonstrate. For instance,
the following four sets of imputations collectively define the total symmetric sets of equilibrium institutional relationships. (Here \( x_2 \) is the buyer with the biggest imputation, \( x_3 \) the second biggest and \( x_4 \) the smallest.)

I. The core-market: \( X^I = \{x \mid x = (60,0,0,0)\} \)

This is the unique core imputation yielding a price per unit of 90¢. It is identical to the neoclassical market solution and hence we call it the market solution.

II. The two trader symmetric cartel: \( X^{II} = \{x \mid x_1 = (60 - x_2 - x_3 - x_4, 15 \geq x_2 = x_3 \geq 0, x_4 = 0)\} \)

Here a cartel of two buyers forms and excludes the third buyer. The set of imputations defined is one in which the price is reduced below its competitive market price of 90¢ to any price between 90¢ and 75¢. All traders buy at the same price.

III. The three trader symmetric cartel: \( X^{III} = \{x \mid x_1 = 60 - x_2 - x_3 - x_4, 20 \geq x_2 = x_3 = x_4 \geq 16-2/3\} \)

Here, all three buyers form a cartel and bargain with the seller as a unit. Because of their collusion they are able to force the price into the interval 60¢ - 65¢.

IV. Three trader asymmetric cartel with discriminated buyer:

\( X^{IV} = \{x \mid x_1 = 60 - x_2 - x_3 - x_4, 18-1/3 \geq x_2 = x_3 = c \geq 15, 37 1/3 - c \geq x_4 \geq 0, x_4 \in \phi (C)\}. \)

Here the three buyers form a cartel, bargain with the seller as a unit but do not split the gains from collusion equally. Rather, one buyer is discriminated against, who we are assuming in this case is buyer 4, and is merely given a side payment for his cooperation.
Notice that all of these different standards of behavior or institutional arrangements are logical possibilities for what may emerge from the situation of primitive exchange described before and that neoclassical theory misses the opportunity of predicting the emergence of any institution other than the competitive market (in this case $X^I$) which it assumes to exist at the outset of the analysis. Hence, from an institutional point of view the analysis must be considered myopic.

Given the flexibility of the cooperative game theoretical approach, one might have expected game theorists to have derived a more institutionally rich theory of value than their neoclassical counterparts, but this was, unfortunately, not the case. Rather what game theorists chose to do was to concentrate almost totally on the core solution concept and prove a set of limit theorems [Scarf (1963), Scarf and Debreu, Arrow and Hahn (1971), Böhm (1974)] and theorems for economists with a continuum of traders [Aumann (1964), Hildenbrand (1974)] which demonstrate that as the economies we investigate get large in an appropriate manner (or are "large" to begin with) the set of core-stable price-institution arrangements converge to the competitive price-competitive market arrangement (or are equivalent to it) so that when the analysis is over what we have left is an economy that is not any richer institutionally than the neoclassical analysis which merely assumed that this degenerate set of market institutions existed at the outset. Hence, rather than replacing the neoclassical analysis the cooperative game theoretical analysis of the 1960's and 1970's actually vindicated it by justifying the price taking (and therefore the institutional) assumptions that the neoclassical theory made.

In addition to failing institutionally, there are many other reasons why cooperative game theory which uses the core solution concept cannot be
considered an adequate approach to the theory of value.

First of all the assumptions of coalition formation are too severe informationally to make the model realistic since coalition formation is a costly process and if the number of players is large these costs are likely to be prohibitive. Inclusion of these costs led Shapley and Shubik (1966) to the concept of the ε-core yet this is still not a totally satisfactory concept [see also Grodal (1972)].

Second, the process of price formation through face-to-face multilateral bargaining is just not an adequate empirical description of how prices are actually formed in large economies. Put differently, it cannot be considered an advance over the idea of a fictitious Walrasian auctioneer or a step toward greater realism.

Third, and more importantly, the core solution concept is not stable under rational expectations or, as Morgenstern and Schrödter (1976) call it, under "theory absorption," since if traders in the economy know the theory of the core they are likely to stop the recontracting process at some imputation outside of the core by forming a cartel (see Braunstein and Schotter (1978) for an experimental study supporting this assertion). Hence, the core is likely to be arrived at only if the agents in the game do not know the theory behind it. Once it is learned, it becomes a self-defeating concept.

Fourth, as Aumann (1973), Postlewaite and Rosenthal (1976), Schotter (1979) and Maschler (1976) have shown, the core may lead to some counter intuitive results in which cartels or syndicates receive core imputations which are worse for them than the imputations these syndicate members would have received had they not formed a syndicate. To deal with this problem Maschler (1976) advocates the use of the bargaining set and not the core.
Finally, there is one criticism that one can make about all of cooperative game theoretical analysis of the theory of value that is simultaneously the most frequently heard criticism and the least correct. It is that the theory does not predict unique outcomes but rather predicts outcomes that are so indeterminate that they are of little use. But this criticism is only relevant if the object of study of our analysis is merely an equilibrium price given a fixed institutional structure. If the object of investigation is both prices and institutions, however, the criticism is severely weakened, since it is unlikely that any economic or social situation will yield a uniquely stable institutional structure along with a unique imputation. Rather, a set of possible structures along with their associated imputations is really all we can ask for as a solution.

b) The Non-Cooperative Game Theoretical Approach

The fact that the cooperative game theoretical approach employing the core as a solution concept has basically failed to liberate economics from its neoclassical institutional straightjacket does not mean that all of game theory has failed in this mission. In fact, there have been three distinctly game theoretical approaches that have been deeply concerned with integrating institutions into economic theory. These approaches I will call the positive approach [Shubik (1975), Shapley and Shubik (1977), Dubey and Shapley (1981)], the normative or comparative approach [Hurwicz (1973a, b), Maskin (1978), Dasgupta, Hammond and Maskin (1978)] and the evolutionary or organic approach [Schotter (1981), Berman and Schotter (1980)]. These approaches differ primarily in their view of how institutions are created in that in the Shubik et al. and the Hurwicz et al. approach all institutions are planned and designed mechanisms engineered by the modeller or some outside
social planner, while in the evolutionary approach institutions are seen as unplanned phenomena which are created by the players or agents themselves to help them solve a set of recurrent problems. Here, the purpose of the analysis is to predict which institution (or regularity in behavior as Schotter (1981) defines them) will emerge as the stable institutional arrangement when several such stable arrangements may possibly emerge. The emphasis is then on institutions which emerge by human action but not by human design as Hayek (1955) would say or on the "organic" evolution of institutions as Menger (1963) would call them.

Let us look at these approaches one at a time.


The first person to comment on the institutional shortcomings of the cooperative game theoretical approach to the theory of value was Martin Shubik (1973) in a series of working papers on the theory of money and financial institutions. Shubik's interest was in creating an institutionally realistic theory of value in which the non-cooperative Cournot-Nash equilibrium concept was to replace the cooperative core solution concept as the central analytical device [see Shapley and Shubik (1977), Dubey and Shapley (1981)]. [Debreu (1952) and Arrow and Debreu (1954) use a non-cooperative approach to establish the existence of a competitive equilibrium but the model they used was institutionally similar to the standard Walrasian model of Debreu (1959) in that it still employed a fictitious auctioneer and did not define roles for non-equilibrium transactions.] To do this it was necessary to introduce money as the strategic variable used by the agents, but the introduction of money led to the further need to specify a wide variety of other institutions in order to close the model and create
a well defined game. For instance, if money exists is it fiat money or commodity money? If it is fiat money then banks are required to issue and lend it so the model must contain banks. But if people borrow money from banks what happens to those traders who borrow more than they can pay back? To specify these penalties we must have bankruptcy laws. In addition, once we introduce money how are the prices of goods and their allocations dependent upon the money bids of traders and the stock of money? To answer this question a wide variety of market institutions, clearing houses and warehouses must be specified. Consequently, when one takes even one small step in this non-cooperative game theoretical direction it is inevitable that one will come away with a variety of very rich institutional models filled with a variety of specific real world institutions such as money, banks, bankruptcy laws, marketing institutions, clearing houses, warehouses, etc. The next step for the modeller is to investigate the impact of these explicitly introduced institutions on the economics studied to see how the resulting allocations and prices associated with each specific set of institutions are related to the neoclassical set of Walrasian prices and allocations (or any other set of outcomes, for that matter).

What has been shown, miraculously, is that for a wide variety of these non-cooperative models the Nash equilibrium of the games defined converge, in the limit, to the set of competitive equilibria [Shapley (1977), Dubey and Shubik (1979) or are equivalent to them if the economy is "large" [Dubey and Shapley (1981), Dubey and Shubik (1979)]. (The latter discusses the impact of bankruptcy on the equivalence of competitive and Nash equilibrium for a non-cooperative model of exchange.) The fact that these limit and equivalence theorems exist in this non-cooperative literature as they did on the literature on the core does not leave it open
to the same criticism we leveled at the core since, from an institutional point of view, these models are extremely rich in institutional detail and contain a wide variety of real world-like institutions all of which are missing in the cooperative game theoretical analysis. The fact that many of them define economies whose limit allocations and prices are Walrasian is more a comment on the robustness of the Walrasian equilibrium than a shortcoming of the non-cooperative approach. What it demonstrates is that the key element in establishing Walrasian outcomes and prices is the smallness of the individual agent with respect to the entire market and not necessarily the precise institution used for trade. It may be that a wide variety of institutions have these limit properties. Before the limit is reached, however, the outcomes resulting from these various institutions may be quite different. For instance, in the standard non-cooperative models of Shapley and Shubik (1977) the competitive equilibrium is approached "from below," as they say, or from allocations that are non-optimal, while in the core analysis all allocations in the analysis are always members of the Pareto-optimal set since the set of imputations over which we search for the core is, by definition, the individually rational subset of the Pareto surface.

To conclude this section it is important to note that I have called this approach the "positive" institutional approach since the emphasis is solely upon the properties of pre-designated institutions without any normative judgment being made about them. If one is concerned with such normative questions, one is advised to look at the work of Hurwicz (1973a, b), Green and Laffont (1979), Groves (1979), and Dasgupta, Hammond and Maskin (1979) for answers. Let us consider their approach.
2. The Normative Institutional Approach (Hurwicz et al.)

If one views positive economics through the non-cooperative institutional game theoretical perspective discussed above, one's definition of normative or welfare economics must be changed [see Schotter (1981), chapter 1 for a discussion of this point]. This change would involve a shift away from viewing welfare economics as a discipline whose job it was to investigate the properties of various states of the economy (i.e., various allocations of resources) and towards one that investigated the properties of various economic institutions. Hence, instead of ranking social allocations in terms of their social welfare properties, welfare economics would rank various abstract sets of rules or social institutions according to some relevant social welfare criteria. However, since games are nothing more than abstract sets of rules, game forms, combined with a set of utility functions, welfare economics becomes the study of the welfare properties of n-person games analyzed by comparing the social states defined at their equilibria (where the equilibrium concept can be either Nash, strong Nash, Bayesian, Minimax, or the dominant strategy equilibrium).

The problem in this context then becomes one of studying various allocation or voting institutions (or mechanisms) to see if they implement some pre-assigned set of social outcomes. To be more precise, consider a society with n (> 3) agents indexed 1 = 1, ..., n who must choose some alternative a from a set A. Each agent has preferences over A as represented by a preference ordering 1. Let R be the set of all possible preference orderings and R be an n-tuple or profile of all agents orderings \( R = (R_1, ..., R_n). \) The space \( \mathbb{R} \equiv (R)^n \) is the space of all profiles.

Now the key informational assumption is that while each agent knows his own preferences, \( R_i, \) he does not know anyone else's and, more importantly,
the social planner, whose job it is to choose some \( a \in A \), does not know the preferences of any agent at all. Hence, the planner, in order to make the proper choice for society, where "proper" will be defined below, must rely on messages sent by the agents to him in order to make his choice. Hence, let \( M \) be the space of all messages that can be sent from any agent to the planner and set \( O(\cdot) \) be an outcome function mapping each n-tuple \( m = (m_1, \ldots, m_n) \) into an \( a \in A \), i.e., \( O : (M)^n \rightarrow a \in A \). An institution or mechanism can then be defined as a pair \( I = [M; O(m)] \). Such an institution or mechanism is what Gibbard (1973) has called a game form and can be analyzed as an n-person game by specifying a preference profile \( R \in R \).

Consequently, the institution or game form \( I = [M; O(m)] \) defines an n-person game \( G(R; I) \) in normal form \( (N; <S_i>^n, <R_i>^n) \) where:

1) \( N \) is the set of players
2) \( S_i = M \) is each player's strategy set, and
3) \( R_i \) is players' preference of joint strategy n-tuples \( m \in S = \prod_{i=1}^{n} S_i = (M)^n \) defined by the preference ordering \( R_i \) and outcome function \( O(m) \); i.e., \( m \preceq_i m' \) iff \( O(m)R_iO(m') \). [See Groves (1979) for a full description of this setup.]

Now given the game \( G(R; I) \) defined by the preference profile \( R \) and the institution \( I = [M; O(m)] \), we can define an equilibrium rule for this game as a mapping \( \phi: G(R; I) \rightarrow m \in M \) or as a function \( \phi(R; I) \) mapping each game into an equilibrium n-tuple of messages \( M = (m_1, \ldots, m_n) \in (M)^n \). Obviously this rule will depend on the equilibrium concept we use for the game and we can choose between the dominant strategy equilibrium the Nash, the strong Nash, the Bayesian or the minimax.
The relevant welfare question has been described as follows: If the planner had full information and was mandated by the population to maximize a social decision function $F(R)$ mapping preference profiles into alternatives, he could, for any profile, choose that alternative that was optimal. This is designated by the top part of the triangle in diagram 1.

$$\begin{array}{c}
R \\
\downarrow \phi(R;I) \\
(M)^n \\
\downarrow \psi(R;I) \\
A \\
\downarrow O(m)
\end{array}$$

However, since he is not privileged to such information he must design an institution which, when coupled with the players' preferences would define a game $G(R;I)$ whose equilibrium messages sent to him would be defined by the rule $\phi(R;I)$ (see left side of the triangle in diagram 1). These messages would then be used by him to decide upon a social alternative $a \in A$ using the outcome function $O(m)$. The question is, can he design an institution such that for any preference profile $F(R) = O(\phi(R;I))$. In other words, can he design an institution that, no matter what the preferences of the agents, defines equilibrium outcomes to the associates game that are identical to the outcomes that he would have chosen had he full information as to the agents' preferences to start with.

This literature places the normative economic question on the comparison of abstract sets of rules or game forms rather than on the set of social states themselves and makes the entire analysis game theoretical. The relevant question becomes for what types of economic environments and solution concepts can we find an institution which is such that $F(R) = O(\phi(R;I))$ -- for which types of environments and solution concepts can
we find institutions that implement our social decision function and what properties do these institutions have (i.e., are they dictatorial, "balanced" etc. [see Hurwicz (1973a)]. For a thorough investigation of this question see Dasgupta, Hammond and Maskin (1979), Hurwicz, Maskin and Postlewaite (1978), Green and Laffont (1979) and Groves (1979).

3. The Evolutionary Approach [Schotter (1981), Berman and Schotter (1980)]

Despite all of our talk about economic and social institutions it is ironic that we have not, as yet, defined what they are. The reason for this is that there is not a clear consensus among social scientists as to exactly what institutions are, although they are an extremely important concept that is repeatedly referred to. From my own perspective there are two main conceptions of what economic and social institutions are. One, which is common to the work of Shubik et al. and Hurwicz et al., is to view economic and social institutions as abstract sets of rules which constrict the behavior of the agents functioning in them and defines outcomes as a result of the joint actions of these agents. In technical terms institutions are game forms. But there is another view of social and economic institutions discussed by Schotter (1981) which does not concentrate on the rules of the game defined by a particular institution but rather on the regularities in behavior or social conventions [see Lewis (1969)] that the agents create when they repeatedly or recurrently interact in a particular social situation or game form. In this view it is not the rules of the game that are of importance but rather the equilibrium behavior that emerges endogenously or organically given the rules. Also, in this view the rules themselves may be endogenous so that the institutions created may not be planned institutions but rather unplanned evolutionary mechanisms. Let us examine this idea more
closely by examining what David Lewis (1969) has called the "telephone game."

The story behind this game is as follows. In Oberlin, Ohio there was a private telephone company that did not have enough telephone lines to service the entire town. Consequently, whenever one person in the town called another he would be given there minutes in which to talk and then the company would disconnect the line. The problem created was: if the conversation was not completed who would call whom back? This problem can be portrayed by the following game matrix:

\[
\begin{array}{c|cc}
\text{Callee} & \text{call back} & \text{wait} \\
\hline
\text{call back} & 0,0 & 2,2 \\
\text{Caller} & 2,2 & 0,0 \\
\end{array}
\]

Here we see that each player, the caller and the callee, has to decide whether they should call the other back or wait. If they both wait, neither phone rings and they are standing there waiting next to silent phones. If they both try to call the other, they both get busy signals and still cannot continue their conversation. Obviously, they will only be able to continue if one calls back and the other waits. The question is, which one will call back and which one will wait?

Since the problem was a recurrent one in Oberlin, Lewis argues that eventually some convention of behavior will be established that will define who calls back and who waits. Hence, it may be established and become generally known that the caller is the one who always calls back or always
waits and this rule or convention will get regularized and learned by the
town's citizens. Such a regularity in behavior which is created or evolves
to solve a recurrent social or economic problem is what Lewis (1969) calls
a convention and what Schotter (1981) calls a social institution. The
Schotter definition is merely an extension of the Lewis definition and
appears as [(Schotter (1981), p.11):

A regularity $R$ in the behavior of members of a population $P$ when they are
agents in a recurrent situation $\Gamma$ is an institution if and only if it is
true that and is common knowledge in $P$ that (1) everyone conforms to $R$;
(2) everyone expects everyone else to conform to $R$; and (3) either everyone
prefers to conform to $R$ on the condition that the others do, if $\Gamma$ is a
coordination problem, in which case uniform conformity to $R$ is a coordination
equilibrium; or (4) if anyone ever deviates from $R$ it is known that some or
all of the others will also deviate and the payoffs associated with the
recurrent play of $\Gamma$ using these deviating strategies are worse for all
agents than the payoff associated with $R$.

Consequently, in this view of social institutions, institutions are
unplanned evolutionary regularities in behavior that are created by the
agents themselves to solve a series of recurrent problems that they face.

In formal terms, social institutions in this view can be thought of
as the non-cooperative Nash equilibria to a variety of supergames that
economic and social agents face. The problem that must be solved by the
analyst then is to specify which equilibrium is likely to be settled upon
by the players in the game as the equilibrium convention of behavior to
adhere to. In this connection it is the contention of Schotter (1981) and
Berman and Schotter (1979) that the exact equilibrium convention or insti-
tution that emerges is a stochastic event since it depends upon how the
agents learn about the intended actions of the other. Hence, they view the
process as a Markovian process in what they call the state space of social
norms whose absorbing states are associated with the equilibria of the
supergame since they represent states in which each agent expects all other agents to adhere to a particular convention with probability one and given these beliefs each player's best response is to actually adhere to that convention. It becomes a rational expectations self-fulfilling equilibrium.

Now it would not be completely correct to say, as I did before, that the difference between this approach to institutions and the ones presented above is that those approaches concentrated upon the rules of the institution while this one concentrates upon the regularities of behavior created by the agents given the rules, since one of the regularities established by the agents may be what types of rules or modes of conduct should be adhered to and which should be ignored. For instance, consider a duopolistic market where firms meet each other regularly year in and year out and can compete with each other using price, quality, advertising and service as strategic variables. Each player can then compete using any one of 15 different strategic variables, i.e., price, price and quality, advertising, price and service, etc. But we know from watching oligopolistic industries that over time they evolve conventions of behavior which inform all of the members of the industry which types of strategies are "allowable" and which are considered unacceptable and are to be punished if used. As a result, the industry might evolve into one in which all strategy variables are acceptable or into one where price competition is ruled out but all other types of competition are acceptable. Which will actually occur is a function of the history of the industry and the trust and norms developed, but it should be clear that what is emerging in this industry is the set of rules that all the firms will adhere to so that even in this type of analysis the rules may still be the object of study. The only difference is that the rules are looked upon as endogenous variables as opposed to exogenous variables designed by some social planner.
Section III: Conclusions

To answer our originally posed question—Why take a game theoretical approach to economics?—one can say that game theory is the only tool available today which holds out hope for creating an institutionally realistic and flexible economic theory. It allows an analyst to rigorously describe and analyze an economic system under a wide variety of institutional assumptions as opposed to the degenerate institutional framework of neo-classical theory.
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