Is Game Theory redundant?

Stefan Nepal
Erasmus

Why do people bother studying game theory? Are they merely misinformed about its relevance or are they anticipating the natural scepticism of mainstream economists when faced with a new theory? Stephen Nepal argues that they might be acting rationally after all....

> "Game theory is largely redundant. For the most part it formalises over-simplistic and unrealistic economic problems and even, where the problems may be interesting and relevant, the results are either inconclusive or so intuitive that they could have been known in advance."

Introduction

Game theory is the theory of rational, strategic interaction. The notion that it is redundant could already be rejected on a very abstract level: no theory is redundant as it always has either the potential of explanatory progress or it indicates that no progress can be made in a specific direction of research (if it is already falsified). The above statement, however, deserves consideration in more concrete terms as it reflects a common prejudice against theorising in general and game theory in particular. Therefore the two allegations that are expressed in the quotation will be examined and factual deficiencies of game theory contrasted with its merits.

Are game theoretic problems over-simplistic and unrealistic?

As with most theories game theory helps us describe, investigate, explain, predict and prescribe. Abstraction and simplification - as they allow us to focus on a specific area of reality - are essential for this achievement. A 'realistic' map of Dublin would be a copy of it and could neither help describe Dublin, nor could one better find one's way with its help.

The notion that the problems game theory deals with, or the reduced-form models, which are typically analysed, are over-simplistic, merely is an opinion. But that it simplifies and abstracts from reality is, in contrast, a fact. Game theory forces real world interaction into a mould which is determined by the present state of the theory. If one takes into account the relatively short history of game theory - the link between its mathematical core and economic theory was only established in 1944 by Oskar Morgenstern and John von Neumann - one has to acknowledge that this mould is already quite flexible. Von Neumann and Morgenstern achieved a major breakthrough with their discussion of two-person zero-sum

games, but today's game theory deals with much broader classes of games which include many more realistic ones. The example of auctions of broadcasting rights with very different success in New Zealand and the USA clearly demonstrates that game theory can be of practical use, and can promote economic efficiency[1].

Still, many crucial assumptions on which game theory is built are not realistic. The restriction to rational economic agents is especially simplistic. Though we may be subjected to a sort of economic evolution that will, perhaps, one day turn Earth into an entirely rational planet most individuals very often do not behave rationally in the sense of game theory, or only when big sums of money are at stake[2]. Their behaviour is influenced by past experience in other 'games' with other 'players', by social conventions, by limited and individually different intellectual abilities. People do not decide according to a well-defined, well-behaved von Neumann-Morgenstern payoff or utility function most of the time. The whole definition of rationality applied by game theory is simplistic and arbitrary. 'Rationality' is philosophically disputed, not necessarily being the maximisation of expected utility subject to certain constraints - it could be Kant's categorical imperative instead.

Neither are there many single-shot games in reality (because of experience, reputation, etc.), nor can stable rules of games be taken for granted. Often enough rules are the dynamic outcome of an earlier stage of the 'game' or even another 'game'. But, even if the situation of real prisoners is nowhere as simple as in the Prisoners Dilemma - they may be friends, want to be a hero, are tired ...- one can still learn a lot from it. Simple examples are usually more instructive than complicated ones. For example, the Prisoners Dilemma or the Problem of the Commons are most illustrative of the effect of externalities. They show that inefficient outcomes can arise through rational behaviour - but also that the evolution of co-operation amongst rational agents is possible in repeated versions of the games[3]. They provide a serious argument for state intervention as a co-ordinator of economic activity and demonstrate how a probable future and its relative importance influence people's behaviour. Credibility and reputation are addressed by concepts like sub-game perfection (time-consistency), which produce new insights into the role of monetary policy. Phenomena of real time

[1] see for example: McMillan (1994)

[2] Consider the following simple ultimatum game: You are offered £100 to share with the author of this essay. You offer me a certain part of the money. If I reject your offer, none of us will get anything. How much would you offer me to get my consent? If I were to move first and offered you a share of £1 only, would you accept? Would you accept, when £100,000 were at stake and I offered you £1,000?

[3] Axelrod (1984)

are successfully investigated when the impacts of first-mover advantage, patience and outside options on the outcome of a bargaining process are made distinguishable. Simple, non-realistic examples which still capture the characteristic feature of a more complicated problem can be very helpful to understand the complex reality.

Even the fact that certain predictions of game theory have been empirically falsified is instructive, and extends knowledge. As game theory is more liable to empirical refutation than the competing neo-classical orthodoxy, game theory can be considered more of a science than the orthodoxy, and many even more religion-like fields, in economic theory. Contrasting game theory with neo-classical microeconomics also shows that game theory is, in fact, a move towards more realistic, less simplistic economic theory. It takes into account the agents' knowledge, what they think about other agents' knowledge and how they expect them to use it. Thus, it is not restricted to the problems of monopoly and perfect competition - which are, in fact, rarer in reality than the problems game theory deals with.

Game theory formalises, and it also simplifies and abstracts from reality. But we can not call the problems and the theory dealing with them over-simplistic and too unrealistic to be of use.

Is Game Theory inconclusive, its results basically intuitive?

The second common allegation, as expressed in the above quote, is more specific to game theory than the first one which could have been directed at most strands of economic theory. In fact, game theory does not provide a universally valid criterion of choice in the case of *multiple equilibria* (e.g. in simultaneous-offer bargaining or Battle of the Sexes[4]) and very often only predicts a mixed-strategy equilibrium (e.g. in the Welfare Game) which can be considered equally inconclusive. The whole notion of equilibrium can be regarded as arbitrary, like the several refinements that serve to rationalise almost any Nash equilibrium outcome or even non-equilibrium outcomes.

But one must not neglect that the replacement of the concept of rational outcome from the individual's point of view with that of strategic equilibrium by John Nash in 1950 has opened game theory to a much broader class of problems. The Nash theorem, demonstrating the existence of at least one such equilibrium in the most relevant classes of games, is a very conclusive result. Equilibrium refinements like weak dominance, subgame perfection[5] or that of trembling-hand

4 for normal or extensive form presentations of mentioned games see for example: Rasmussen (1994)

5 Selten (1965)

perfection[6] have strengthened the power of game theory as an analytical tool. They allow us to formalise intuitive behaviour like backward-induction to identify non-credible threats, spontaneous and counter-theoretical actions, decisions based on independent events outside the game (concept of correlated equilibrium) and players' reaction to incomplete information (concept of Bayesian equilibrium[7]). If intuition is formalised it can be taken further and applied in new contexts and to more complicated problems. Thus game theory frequently overtakes intuition - who could solve the Rubinstein sequential-bargaining game in an optimal way merely by intuition? The different approaches to bargaining made by Nash[8] and Rubinstein[9] may highlight "known facts", e.g. that more patience, a better outside option or favourable *status quo*, high bargaining skills and risk-neutrality lead to a bigger share of the surplus from trade. But these results give useful insight and conclusive predictions. The incorporation of private information can even produce a rational explanation of strike and conflict occurrence. Very conclusive results and recommendations are also provided by the game-theoretic analysis of auctions[10].

Even when the predictions of basic intuition and refined game theory coincide this does not make game theory redundant. It provides a mutual test of the explanatory power of game theory and the economic reliability of intuition. Certain results may be intuitive to common people, but not to economists, and *vice versa* - and game theory can provide a link between them. Still, predictions of game theory can very often appear to be inconclusive, for example in games of co-ordination, where focal points are a somewhat arbitrary solution to the problem of *multiple equilibrium*, or when the existence of an optimal strategy in chess is proved but this strategy cannot actually be formulated. But this mainly reflects the nature of these problems, not serious flaws in the theory. Game theory can only be used to solve certain, suitable problems. Just like one cannot go fishing with Petri nets, one should not expect game theory to solve poker.

As game theory produces conclusive and better-than-intuitive results in many cases, the problems described are not sufficient to call the theory redundant or largely redundant.

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6 Selten (1975)
7 Harsanyi (1967-8)
8 Nash (1950b)
9 Rubinstein (1982)
10 see for example: Milgrom (1989)

Merits of Game Theory

As a theory which is claimed to be useful should provide more than merely a tolerable amount of deficiencies, it is convenient to remind oneself that game theory does so. Game theory is of use, and therefore not redundant, because

- it offers a new language (hence a new perspective) and powerful tools,
- its mathematical structure invites logical testing and establishes explicit links between assumptions and predictions,
- it predicts where economic behaviour tends to,
- it improves the strategic behaviour and also the intuition of its students[11],
- it illustrates the role of information and externalities in economic activity and helps to design mechanisms that deal with the associated real-life problems effectively,
- it provides an alternative to the neo-classical school of microeconomics and the neo-Walrasian approach,
- it invites fruitful exchange between economists, psychologists and sociologists,
- it is constantly evolving - opening itself to broader, more realistic, less simplistic problems - and providing more refined results.

Conclusion

The quoted statement is correctly pointing at problems and limitations of game theory. Its conclusion to call game theory redundant is based on ignorance of the merits of this relatively new analytic tool. Having both merits and defects in mind, I personally consider game theory useful and in no way redundant, in addition to the general remark made in the Introduction. Game theory is subject to ceaseless progress. Focusing, for example, on trial-and-error learning processes of agents with bounded rationality can make it still a lot more realistic and less simplistic - though results might then become less straightforward and determined. Game theory should also produce a clearer idea of what it can do and cannot do at the present state. This would probably help to avoid hectic judgements like the one that was dealt with in this essay.

Bibliography

Axelrod, R. (1984) *The Evolution of Co-operation,* Basic Books, New York.

Harsanyi, J. (1967-8) 'Games with incomplete information played by Bayesian players', *Management Science.*

[11]Does this imply that the increasing number of economists with game theoretic knowledge will make socially sub-optimal outcomes more likely because of their more rational strategic approach to game-like situations?

McMillan, J. (1994) 'Selling Spectrum Rights', *Journal of Economic Perspectives.*

Milgrom, P. (1989) 'Auctions and Bidding: A Primer', *Journal of Economic Perspectives.*

Nash, J. F. (1950a) 'Equilibrium points in n-person games', *Proceedings of the National Academy of Sciences USA.*

Nash, J.F.. (1950b). 'The Bargaining Problem', *Econometrica.*

Rasmussen, E. (1994). *Games and information,* Blackball, Cambridge MA.

Rubinstein, A. (1982). 'Perfect Equilibrium in a Bargaining Model', *Econometrica.*

Selten, R. (1965). 'Spieltheoretische Behandlung eines Oligopolmodells mit Nachfrageträgheit', *Zeitschrift für die gesamte Staatswissenschaft.*

Selten, R. (1975). 'Re-examination of the perfectness concept for equilibrium points in extensive games', *International Journal of Game Theory.*

von Neumann, J. & Morgenstern, O. (1944). *The Theory of Games in Economic Behaviour,* Wiley, New York.