

ON JOHN NASH'S SCIENTIFIC CONTRIBUTIONS

by

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1 Introduction

John Nash has made fundamental, path breaking contributions to game theory and economics. The concept of equilibrium which bears his name is arguably the most important concept in economic analysis. Indeed, the Nash equilibrium concept is a fundamental tool of analysis not only in economics, but also in several branches of political science.

John Nash made his second monumental contribution on the important topic of bargaining. His general approach to the study of bargaining, and the specific framework that he laid down in the 1950s, lies at the heart of modern bargaining theory. As a direct and indirect result of his contribution to the topic of bargaining, we now have a much better understanding of many real-life negotiations. For example, we now have a deeper understanding of what factors determine a negotiator's bargaining power, and what factors might enhance the likelihood that negotiators are able to strike an agreement.

¹I thank Petros Raptis, the Event Coordinator, for kindly inviting me to write a short article discussing John Nash's scientific work. This article will be translated into Greek, and then read during a ceremony in Athens in June 2000 to honour John Nash for his contribution to science. I am grateful to Roy Bailey, Francisc Kiraly and Chris Minns for their helpful comments on this article.

2 Nash's Equilibrium Concept

The importance of the Nash equilibrium concept in economics is self-evident to professional academic economists, to research students of economics and to anyone who has taken an economics degree over the past ten years. Indeed, it would become self-evident to anyone looking at any current respectable academic economics journal. Almost any journal article that aims to provide a theoretical analysis of almost any economic problem will use the Nash equilibrium concept, or one its variants. The Nash equilibrium concept is as fundamental to economic analysis as are Newtonian laws to theoretical physics.

The Nash equilibrium concept solves in a plausible and fairly tractable manner the basic problem of human interaction, which is to determine the behaviours and actions of two or more individuals or organisations (such as firms, political parties and governments) when the behaviours and actions of all these parties potentially affects each party's welfare (or payoff). Much human interaction (be it economic, political or social) is of this type; that is, a party's welfare (or payoff) depends not only on his or her actions but also on the actions of other parties. This type of situation is known as a 'game' situation. In such a strategic situation, the best (or optimal) action for a player (such as an individual, a firm or a government) depends on the actions chosen by the other players, and vice-versa. Which action, then, should a player choose to achieve her objectives? The Nash equilibrium concept provides the answer to this essential question. Once an answer to that question is provided, only then can we address other interesting and important questions such as what might be the impact of a policy or a new piece of legislation.

As mentioned above, if there is a theoretical literature that provides an economic analysis of almost any topic of interest to economists, it will almost surely use the Nash equilibrium concept. The analysis of human interaction in areas that are yet to be subjected to theoretical analysis will most likely be based upon the Nash equilibrium concept. For example, the recent surge of papers that provide an economic analysis of corruption have been based upon this equilibrium concept.

Over recent years, the Nash equilibrium concept has come under scrutiny. Ideas that were, perhaps not surprisingly, suggested by John Nash himself in the 1950s, have been formally developed to explore the possibility of providing firm foundations for this equilibrium concept. The bottom line emerging from the literature on the foundations of Nash equilibrium (which includes the evolutionary and learning models) is that the

Nash equilibrium concept is more robust and well-founded than some of its variants, providing further support for it. Even if there are some minor qualifications, this equilibrium concept is so beautiful, so intuitively appealing, and so easy to use that even if it is a little imperfect it will most likely remain a fundamental concept in economic analysis. Any alternative concept of equilibrium that would claim to be ‘more correct’ would necessarily be more complex, more difficult to use, and more ugly than the Nash equilibrium concept, and thus would fail to replace the Nash concept. In an analogous manner, Newton’s laws of motion have also stood the test of time, despite the subsequent important developments in theoretical physics.

3 Nash’s Bargaining Theory

In a series of papers in the 1950s, John Nash showed how to approach the study of bargaining in a coherent, rational and elegant manner. His work led the way to the development of the modern theory of bargaining. Before Nash, it was considered practically impossible to develop a theory that could address the question of what factors determine the outcome of negotiations. It was argued that bargaining is inherently dependent upon factors that are difficult to formulate such as the vague notion of the negotiators’ bargaining skills. As such, bargaining — an ubiquitous phenomenon — was considered outside the scope of rational economic analysis.

The modern theory of bargaining, which is based on Nash’s formulation of the bargaining problem and incorporates the specific solution that he proposed, lies at the heart of studies of many real-life negotiations. In particular, Ariel Rubinstein’s celebrated model of bargaining provides a firm foundation for Nash’s bargaining solution. As such, Nash’s bargaining solution is the concept often used in applications of bargaining theory, such as in studies involving firm-union wage negotiations and international negotiations.

Once again, as with Nash’s equilibrium concept, the power of Nash’s approach to the study of bargaining lies in its simplicity, elegance, generality and plausibility. Indeed, several alternative solutions of bargaining have been proposed since Nash’s work. They are all based on Nash’s basic approach to bargaining and on his formulation of the bargaining problem. However, it is his proposed solution that has stood the test of time. This is certainly one way to distinguish a work of a genius. Indeed, if that word is to be applied to any economist or game theorist, Nash would certainly deserve to be called as such.