

An Economics of War & Peace

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Abstract

This paper is meant to provide the reader with a brief historical account of Game Theory's creation, while contextualizing some of the discipline's most notable academic ambitions, political intentions and practical limitations.

Keywords: game theory, strategy, atomic war, conflict resolution.

Introduction

Game Theory is the mathematical analysis of strategic behavior and interaction amongst rational decision-makers, referred to as players. By making several simplifying assumptions, the game theoretic approach attempts to reduce complex problems to very simple ones, which are then solved by finding an equilibrium point through rigorous mathematical models. Popular amongst scholars, gamblers and military thinkers alike, few disciplines have had a range of applications as diverse as that of Game Theory. Since its creation in the early 20th century, this method of problem solving has been used extensively in several fields such as computer science, biology, political science, philosophy and most notably, economics (Leonard, 1995).

This paper first provides the reader with a brief historical account of Game Theory's inception and expansion through the Cold War. It will then focus on one of Game Theory's applications, namely by discussing how game theoretic approaches have been used to reach cooperative outcomes. Finally, we will tackle the question of Game Theory's usefulness, by analyzing some of the discipline's limitations in most practical contexts.

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Rigorization of a Social Science

While the study of strategic games has indeed been carried out before John Von Neumann – notably with French mathematician Émile Borel's series of 1921 papers on "*la théorie du jeu*" – the field of Game Theory is said to be officially born out of Von Neumann's 1928 paper, *Theory of Parlor Games*, which included his famous *minimax theorem* (Poundstone, 1993:41). A few years after his publication, Von Neumann decided to leave Europe and became an appointed professor at the Princeton Institute for Advanced Study where he remained for several years. There, the Hungarian polyglot, logician, quantum physicist and mathematician carried out many projects of remarkable scope, which include contributions to the Manhattan project and the development of the first digital computer to name a few (Poundstone, 1993:76). It was also at the Institute that Von Neumann first collaborated with Austrian mathematician Oskar Morgenstern, with whom he would eventually co-author the ground-breaking book, *Theory of Games and Economic Behavior* (Von Neumann & Morgenstern, 1944). According to Robert Leonard, this seminal book came as a result of the authors' shared ambition to rigorize economics (Leonard, 1995). Through Game Theory, Von Neumann hoped to provide a sound axiomatic system able to tackle all problems of economic nature, in an effort to establish economics as an exact science. This kind of goal was not uncommon amongst many scholars of this period, who amidst an era of mathematical formalism, attempted to extend the axiomatic approach to many disciplines (Leonard, 1995). As for Morgenstern, one can sum up his stance on the importance of mathematical rigour through

his crude criticism of John Maynard Keynes' economic approach, calling him "a scientific charlatan" in a diary entry dating back to 1942 (Leonard, 1995).

After four years of collaborative effort, *Theory of Games and Economic Behavior* was finally published for the Princeton University Press in 1944 (Poundstone, 1993:6). Today, it is considered to be one of the most influential mathematical works of the 20th century and continues to serve as a foundation for most contemporary game-theoretic research.

The Atomic Game

In a 1956 paper titled, *Theory of Games of Strategy*, featured in the Applied Mechanics Review, Melvin Dresher describes the new Theory of Games as one which follows models "patterned on actual parlor games such as chess and poker" (Dresher, 1956). One can indeed trace the development of Game Theory as a direct consequence of Von Neumann's interest in the social interactions of such strategic games and their potential mathematical treatment (Leonard, 1995). But despite its innocent beginnings as a tentative theoretical analysis of card games, Game Theory's first practical application took place during the second World War, and concerned itself with potential bombings against the Japanese forces (Poundstone, 1993:68). By developing a **series** bombing schemes, mathematicians John Tukey and Merrill Flood used Von Neumann's existing work on Game Theory to optimize the efficiency of the nuclear weapon when used against Japan (Poundstone, 1993:68). Von Neumann, who had been nurturing his military consulting experience since 1937 (Leonard, 1995), was not only contributing to the deployment of the atomic bomb but to its design as well. In 1943, he worked with theoretical physicist J. Robert Oppenheimer at Los Alamos to create the implosion bomb, which would eventually be the model used on Hiroshima and Nagasaki (Poundstone, 1993:67).

Fight or Acquiesce

Unfortunately, this was only the beginning of Game Theory's long streak of military purposes. A few years after their pioneering publication, both Von Neumann and Morgenstern took up research positions at the RAND corporation, an American think-tank that supported the United States' military efforts against the Soviet Union (Poundstone, 1993:94). Considered by many as a prime example of "modern Machiavellianism" (Poundstone, 1993:83), the RAND corporation was notorious for the incredible amount of intellectual freedom it gave its scientists and for its aggressive agenda. Employing researchers and academics from a wide range of fields, it quickly became the home to the world's most prominent game theorists and analysts. In the 1940's, MIT professor and RAND consultant John F. Nash went on to study non-cooperative games and extended Von Neumann's analysis of the equilibrium concept. Nash focused on non-zero-sum two-person games, as well as games with multiple players, and proved that every two-person finite game has at least one Nash Equilibrium for which no player can be made better off without changing the other player's

choice (Poundstone, 1993:99). In 1950, two fellow RAND mathematicians by the names of Merrill Flood and Melvin Dresher sought to challenge Nash's equilibrium theory. In doing so, they devised what would become the most researched and best-known game of conflict to exist, the famous *Prisoner's Dilemma*.

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Cold Solutions for a Cold War

When it came to Von Neumann's stance on the Cold War, the mathematician held the firm belief that preventative war against the USSR was the only right option. A quote of his featured in a 1950 issue of *Life* magazine reads: "If you say why not bomb them tomorrow, I say why not today? If you say today at 5 o'clock, I say why not one o'clock?" (Poundstone, 1993:143). But although most of Von Neumann's contributions to Game Theory were used to perpetuate warfare in one way or another, this was not the case for all game theorists. Some academics, much less cynical than Von Neumann, attempted using a game theoretic framework to reach cooperation, rather than achieving victory, in situations of conflict. Thomas Schelling – an American economist and political strategist – is a remarkable example of such thinkers. In his book, *The Strategy of Conflict*, published in 1960, Schelling introduces several new concepts such as "focal points" and "credible commitments" to paint a more realistic picture of conflict situations. He also highlights the importance of interdependent decisions in game theory models and provides the reader with insight concerning the different methods by which cooperation can be reached in games (Schelling, 1960). His later works *Strategy and Arms Control* (1961) and *Arms and Influence* (1966) would also emphasize the importance of limiting of nuclear warfare and the possibilities of promoting nuclear deterrence through Game Theory.

Tit for Tat

Another prominent economist whose contributions to peace research and the study of cooperation are worth noting is Anatol Rapoport. In a 1965 research paper titled *War Hawks and Peace Doves: alternate resolutions of experimental conflicts*, Rapoport and three of his colleagues designed a modified version of the prisoner's dilemma in which players chose a degree of cooperation rather than total defection or total collaboration. This modified game also took into account the personality traits of the participants and proved that circumstances played a great role in determining the likelihood of cooperating (Rapoport et al., 1965). Fifteen years later, Rapoport devised a simple strategy called *Tit for Tat* in which a player would collaborate in the first period then mimic what the other player did on the preceding move for all subsequent periods. The strategy gained recognition after its remarkable performance when it was tested in a series of computer experiments concerning the potential outcomes of a repeated prisoner's dilemma. These experiments, which were conducted by a

Professor of Political Science and Public Policy at the University of Michigan named Robert Axelrod in 1980, consisted in multiple computer “tournaments” in which scholars from all over the world were invited to submit a strategy of their choice and compete in an iterated version of the prisoner’s dilemma (Poundstone, 1993:236). The submitted strategies would then go up against one another in a tournament-like fashion to see which strategies would result in the highest amount of cooperative outcomes over 200 periods (Axelrod & D. Hamilton, 1981). Rapoport’s *Tit for Tat* strategy was the simplest of all the candidates’ strategies and yielded the highest cooperative score during tournaments. Most importantly however, it established a game theoretic justification for biological instances of cooperation while hinting at the promising applications of flexible strategies that urged players towards a reciprocal cooperative outcome (Axelrod & D. Hamilton, 1981).

From Warfare to Welfare

The Evolution of Cooperation, written by Robert Axelrod in 1984, investigates the social and biological structures that dictate the natural behaviors of humans in situations of conflict and cooperation. In Chapter 7, Axelrod summarizes several ways to alter the setting of an interaction in order to encourage cooperative outcomes. These methods include alterations to the players’ payoffs schemes, modifying the players’ opinions and perceptions of reciprocity and altruism, and most notably extending the “shadow of the future” (Axelrod, 1984:126). The repetition of interactions creates a relationship between the players which makes them more likely to settle on mutual cooperation. Similar ideas to those of Schelling and Rapoport would be explicitly and implicitly used in deterring the use of nuclear arms. Additionally, Schelling would dedicate much of his later work to the proliferation of cooperation. In his 2005 Nobel Prize lecture, the economist discusses the “legitimization” of nuclear weapons and how to prolong peace in future years (Schelling, 2006).

Limitations of Game Theory in Practice

Rational Choices, Irrational Assumptions

As promising as Game Theory seemed to be when it first came to life in the early 1900’s, one can hardly claim that its founders achieved their goal of establishing a new exact science of economics. This is mainly due to the many factors that limited the theory’s precision and applications, which include bias and unsupported assumptions amongst other things. As Rapoport put it in the *Scientific American*, “[...] of what practical use are results based on arbitrary assumptions?” (Poundstone, 1992:171). Of these assumptions, perhaps the most concerning one is the Rationality assumption. Most game theoretical models indeed assume that players are perfectly rational and that the outcomes of their games will be purely determined by their payoff matrix. However, both

experimental studies and real-life applications have shown this assumption to be very unreliable (Poundstone, 1992:173). In a response to these criticisms, Oskar Morgenstern insisted that, like any other mathematical model, Game Theory tries to find a balance between simplicity and accuracy, and hence its simplified assumptions will never portray an accurate description of all social interactions (Morgenstern, 1964).

Playing for Fun?

Thorough reflections concerning the impact that Game Theory had on wartime decision-making led many to regard the discipline as an exemplary case of the dangers that a reductionist approach poses to ethics. As Poundstone writes, some went as far as calling it a “tool for justifying the nuclear war.” (Poundstone, 1992:168). This opinion was also expressed by many scholars at the time. In 1970, Anatol Rapoport published a paper titled *Can peace research be applied?* in which he outlines the struggles that come with institutionalizing research and getting public support (Rapoport, 1970). In an earlier paper on Game Theory and its applications, Rapoport also insisted on the importance of discerning between the discipline’s theoretical strengths and its applicability (Rapoport, 1962). Several decades later, many academics still challenge Game Theory’s theoretical claims, and accuse certain game theoretic models of perpetuating the game theorists’ bias and hindering our understanding of conflict situations (Stone, 2001).

Discussion

By the end of the Cold War, the study of cooperation and defection had become a subject of interest to researchers across many disciplines. The frameworks and examples that Game Theory provided were seen as useful and intuitive tools to better understand the ethical questions posed by situations of conflict. From a historical standpoint however, one could argue that Game Theory’s elegant approach might have come at a worrisome cost. Since Von Neumann’s *Theory of Parlor Games*, over a dozen economists have received the Nobel Prize in Economic Sciences for research relating to Game Theory. Today, certain economists are even using Game Theory to help better the design of markets, reduce inequality, and tackle pressing issues such as climate change (Kominers et al., 2017). Whether Game Theory’s usefulness lies in its theoretical importance as a mathematical synthesis of most economic problems, or in the perspective it brings to any study of human behavior, the discipline continues to have an irrevocable impact on the entire field of economics, one whose advantages and downfalls must be acknowledged by the academics who choose to further its applications.

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The Ethics of Market Design

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Abstract

A study of the potential applications and limitations of Market Design in free market economies. In this paper, we discuss how Market Design can solve market inefficiencies and externalities, while examining the limitations of a market design approach.

Keywords: market design, externalities, market ethics, efficient outcomes, game theory, price mechanisms, moral markets.

Introduction

From information asymmetry to negative externalities, market failures are as old of a concept as markets themselves. While common remedies - typically taking the form of authoritative regulation or price mechanisms - attempt to correct these market failures, the novel field of Market Design tries to prevent them from happening in the first place. To do so, market designers rethink the structures and rules that dictate market transactions rather than taking them as given[3]. The inception and application of this approach by economists like Alvin E. Roth has proved to be rather successful in a variety of markets[5]. But can markets always be bettered through design?

In this paper, we examine how market design can solve market failures and externalities, and discuss the limitations of a market design approach with regards to moral hazards. The first part of our paper focuses on the nature of free and organic markets and the externalities they display, and how Market Design can potentially remedy these externalities so as to enhance market efficiency. The second part of our research examines the limitations of Market Design with regards to moral hazards. In comparing the work of Michael J. Sandel on market thinking[7], with that of market designers like Al Roth, we attempt to answer the following question: Are the moral issues encountered an inevitable consequence of a new market's creation, or simply a product of its poor design?

1 Possibilities: Market Externalities

1.1 Don't Panic, it's Organic

How do markets come to be, and what is an efficient market? Simply defined, an efficient market is one where outcomes maximize society's aggregated utility. In other words, an efficient market allocates resources optimally, such that no individual party can be made better off without making another worse off. The way about which an optimal allocation is attained, is what economists tend to disagree on. One common theory of *laissez faire* would have markets regulate themselves and reject the use of government intervention. In his 1945 manifesto "*The Use of Knowledge in Society*", free-market economist Friedrich Von Hayek indeed argues that markets emerge organically, and that an efficient economic system is best achieved through self-regulation and the price mechanism[1]. He explains that reaching an efficient allocation of resources must entail the utilization of knowledge that is dispersed and constantly changing. However, according to his text, adjusting to this dispersion of information in a complete and timely manner is an impossible task to achieve by a single central market planner. Instead, the solution to this knowledge utilization issue lies in the price system, which communicates information directly to market participants. By internalizing changes relating to time and place, prices aptly reflect market conditions to buyers and sellers. In doing so, this mechanism turns the aggregation of market

participants into a form of decentralized market planner. While F.A Hayek is but one of many economists to find this "marvellous" mechanism unmatched in its simplicity and efficacy, market failures and inefficiencies are still of common occurrence in free market economies. One prevailing instance of such market failures with respect to price mechanisms is the concept of *externality*.

As Bucovetsky defines it[6], an externality is a two-party interaction whose effect is ignored. However, in free markets of organic nature, prices often fail to internalize certain externalities out of convenience or lack of information, hence leading to inefficient allocations of resources. Another risk of both positive and negative externalities is sub-optimal production levels due to competition amongst industry players. This issue highlights a major flaw in the price mechanism: its inability to completely integrate market information. Then are externalities and free markets bound to coincide? F.A. Hayek famously said that "the curious task of economics is to demonstrate to men how little they really know about what they imagine they can design"[2]. If it is so, then who is to blame for natural market externalities, how are they expected to be solved, and most importantly, what is the role of market designers with regards to free markets?

1.2 The Power of Design

In his article "The Art of Designing Markets"[4], Nobel Prize laureate Alvin E. Roth defines market design as a process that enables business to "create markets where there were none or fix them when they go wrong". Considered by many as a pioneer in his field, Roth's work on improving kidney exchanges, medical residency programs and Boston school admissions has completely reshaped the way we consider markets. However, while the alteration of a marketplace's rules and infrastructures may initially seem to contradict a free-market economist's ambitions, this may be far from the truth. In the last chapter of his "*Who Gets What - and Why*"[5], Roth quotes Friedrich Hayek for acknowledging the importance of designing systems that ensure prosperous competition within a market. In his comparison of Hayek's views with that of market designers', Roth also distinguishes the task of recognizing a market's particular needs from that of fulfilling a market's needs. Then it seems that regardless of political aspirations, market design can perhaps serve as a useful tool for free and governed markets alike. In trying to achieve efficiency, market design inevitably seeks to minimize risks of externalities. As mentioned by Bucovetsky[6], one particularly pressing case of negative externality is pollution and common resource depletion. In recent years however, market designers have tackled environmental externalities with great innovation. From carbon emission trading, to fishing quota marketplaces and land use incentive auctions, clever designs that utilize price mechanisms can prove to be much more successful, and efficient, than simple taxes and regulation[3]. In most cases, market design attempts to steer interactions towards a desired direction rather than restricting market transactions. By incentivizing players to interact honestly with each other, it allows a market to operate *freely*, and efficiently, within the confines of its respective designs.

2 Limitations: Moral Hazards and Concerns

2.1 Market Constraints

We have briefly explored ways in which market design can triumph in solving externalities while allowing for free markets to operate, but what of instances when design must concede to moral justice?

In his influential work of literature *What Money Can't Buy, the Moral Limits of Markets*[7], political philosopher Michael J. Sandel discusses the moral hazards that new markets often display. His first chapter on market limitations introduces three ways in which queue jumping markets have emerged in the past couple of decades or so. While these markets may appear similar due to their use of time and money as exchangeable goods, they differ vastly from each other in the types of parties they involve, the directions in which they allow transactions to take place, and most importantly, the level of moral concern they raise. Markets for *Fast Tracks* in airports only cause mild levels of ethical discomfort and client frustration. This may be due to the fact that one individual's time-saving purchase does not lengthen another passenger's wait. It is somewhat evident however, that Ticket Scalping for doctor's appointments and Pope visits may cause much more controversy. In his explanation of market reasoning, Sandel considers two main arguments in defense of market thinking. The first, supports an individual's right to dispose of private possessions as they please, whether that possession is money, time, or even organs. However, in several markets, allowing for the use of money puts many participants at a disadvantage. In the case of a Free Shakespeare play, busy individuals can pay line standers and buy there way into the theater, but by doing so, they inevitably reduce the number of seats available to those willing to wait and unable to pay. As for the market for organs, governments generally forbid organ sales and market designers cannot resort to price mechanisms, so as to ensure equity for all patients in need of a transplant regardless of their financial situation[5]. The second argument often brought up by economists states that for a market to exist, it must be benefiting both parties engaging in market transactions, and is therefore maximize society's total utility. Yet, Sandel is quick to point out how this argument can easily be flawed. There is a clear distinction between an individual's ability to pay, and his willingness to pay for a good, which often makes "money" a distorted measure of the value individuals attribute to a good. But how can market design adjust, when price mechanisms are forbidden by law or prohibited by morals?

2.2 Design Constraints

Sandel mentions two obstacles standing in the way of more efficient and morally just markets. The first is that it is difficult to assess who values a good the most, as we often mistake people's ability to wait or pay with their willingness to do so. The second lies in the ethical argument against the use of a price mechanism to reveal people's utilities, as such a mechanism may lead to the

moral corruption of a good that is meant to be free.

If we consider economic efficiency to be but one of many factors that market designers consider when determining what outcome is most beneficial to society[3] then Sandel's arguments are most applicable to all market designers. *Repugnance*, as Roth qualifies it[5], is perhaps at the heart of many of these design and market constraints. Many markets are deemed unethical, or *repugnant* by parties that are not subject to the market's transactions. For example, an individual may strongly disapprove of prostitution without having necessarily taken part in a prostitution transaction in their entire life. When dealing with these *Repugnant* transactions, designers face risks of public retribution on one hand, and the creation of dangerous black markets on the other.[5] But queue jumping is by no means the market where the use of money is most contested, and where alternatives to cash are most needed. Sometimes, cash reluctance is diverted by devising systems that involve matching mechanisms, one remarkable example being that of kidney exchange systems.[5] In other cases, the *repugnance* turns out to be caused by the type of currency used rather than the use of currency itself. The invention of a scrip-based marketplace exclusive to food banks in the US for instance, has dramatically increased the number of donations that Feeding America can gather[3], which goes to show how useful price signals can be under specific circumstances.[1]

Discussion

It is especially apparent in times of crisis and panic how quickly we recognize a market's flaws, and how slowly we adapt to a market's needs. While some markets cause little to no moral hazards and provide ample room for improvement, others display constraints so large it becomes hardly possible to dispute their existence in the first place, let alone improve them by design. At the end of his chapter, Sandel draws the reader's attention to the implications of switching from market economies to market societies[7]. It is true that market designers often consider matters of fairness and equality as priorities[3], but difficulties invariably arise when optimal outcomes come at a moral or social cost. Market Design can indeed mitigate feelings of *repugnance* as it has done in many markets[5]. However, it may also serve as proof of how indispensable market thinking has become to us, showing that we would rather correct moral flaws than forgo of problematic markets all together. Ultimately, Market Design is more of a necessity than a choice. Better design can prevent a lot of the troubles we are encountering today, but in doing so it carries the risk of creating even more ethical noise. In conclusion, the shift from market economies to market societies[7] grants current market makers and market designers a role of unprecedented importance and accountability. The challenge that market designers face is determining how to navigate players towards a an optimal outcome without tampering with moral norms. In designing the markets of the future, understanding the moral implications of economically optimal outcomes as well as the effects a marketplace can have on its stakeholders becomes primordial.

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