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The Effects of Social Norms on Decision-Making in Game Theory

Zhang Yiran

Dunman High School, 10 Tanjong Rhu Road, 436895, Singapore; 20060123zyr@gmail.com

ABSTRACT: Game theory has been widely used in many sectors. However, the varying effects of social norms on decision-making in game theory have yet to be discussed. In this research, the author discusses the impacts different social norms have on decision-making, discovering the different significance of various implicit norms and how the codification of norms works. This is done by using primary data to analyze how priorities and rankings of different choices in the Prisoner's Dilemma game theory matrix are changed by norms. This research also explains the reasons why these norms may be weighted differently in the social context chosen, which is Singapore. The author then concludes that there is high potential for further research in this area and modelling of norms by their significance in game theory.

KEYWORDS: Behavioral and Social Sciences, Other, Game Theory, Social Norms, Rationality.

Introduction

Game theory is the study of how choices of economic agents interact to produce outcomes based on their preferences.[1] It is often used to predict decision-making in fields such as economics and business, as well as behavior in social interactions. However, the latter is often overlooked by traditional game theory, as there is a strong focus on mathematical models, often neglecting behavioral aspects of humans that affect decision-making significantly, especially in social settings.[2] This essay will specifically look into the solution concept of Nash Equilibrium (NE) for all analysis, as it is the most commonly used solution in games.[3]

This essay analyses and expands on the Prisoner's Dilemma Game (PDG) to tackle this inefficiency. The PDG is a situation in which two players are faced with a choice: cooperate with each other or defect.[7] Two prisoners, A and B, are arrested for a crime. The police have enough evidence to convict them of a charge, but with missing information on the specific duration of the charges for which they should be charged. Cooperate means not to betray each other, and defect means that they will testify against each other. If both cooperate, they get a 1 year sentence. If both are defective, they get a 2-year sentence. If one cooperates and the other defects, the defector goes free, and the one who cooperated gets a 3-year sentence. PDG assumes that neither prisoner knows the other's decision, and each only acts to minimize their own sentence. The best response for both players in an ideal rational world would be to defect, which is the NE. This dominant strategy results in 2 2-year sentences for both, which is not optimal, as mutual cooperation would have resulted in lighter sentences. Regardless of the other player's decision, each prisoner gets a better outcome by defecting. This is depicted in a matrix in Figure 1. However, they could have yielded a better result if they both cooperated and ended up with a 1-year sentence. From this, we can observe that the NE of the best responses of players may not always be optimal for themselves.

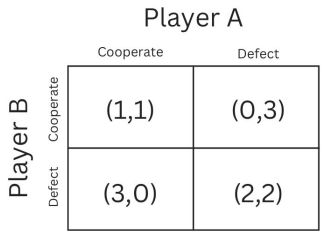

Figure 1: Payoff matrices for PDG, where each cell shows the outcomes for Player A (row) and Player B (column). Mutual cooperation yields (2,2), defection against a cooperator results in the highest individual payoff (3,0), and a mutual defection leads to (1,1).

Issues Related to Traditional Game Theory:

Traditional game theory is useful and widely applied in many fields, such as auction prices, stock market predictions, monetary policies, and duopoly strategies.[5] However, at the same time, due to the utilization of pure mathematics and statistical models, issues and paradoxes arise when game theory is applied in less mathematical but more behavioral contexts.

The first issue lies in the assumption of utility. Agents are utility-maximizing in their decisions, but what is utility exactly? Utility in game theory is a numerical representation of agents' preferences, defined as consistent choice patterns instead of inner motivation.[1] Utility functions then rank these choices, modelling decision-making without assuming anything about emotions or motivations.[1] However, this could be inaccurate depending on varying contexts, as humans may not always be consistent in their choice patterns when they are influenced by different behavioral factors and social norms.

The second issue lies in the assumption of rationality. Game theory assumes that players are economically rational, meaning that they can rank outcomes, understand the connections between decisions and outcomes, and choose the actions that maximize their utility.[1] However, this assumption overlooks the complexity of human nature and behavior, as people often make decisions based on biases, incomplete or imperfect

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information, such as impulsive decisions or procrastination. This opposes the assumption made. Furthermore, players also often lack the ability to process all information available accurately due to cognitive limitations, rendering the assumption inaccurate to some extent.[6] These two issues lead to the insufficiency in game theory when considering cultures and social norms, which is the main theme of this essay. Game theory assumes fixed preferences of individuals and does not account for varying contexts of the agents. This includes cultures, social norms, and interpersonal relationships. Players' choices are often influenced by moral considerations, social pressures, cultural expectations, and emotions, which deviate from pure utility-maximization, as the best outcome for each player varies according to these factors.

Behavioral Economics:

Game theory can be critiqued from behavioral perspectives, and hence, the topic of behavioral economics is brought in as it aids understanding of the limitations of traditional game theory. It will be used in the essay to analyze the impacts of social norms on PDG, as well as the incorporation of social norms in the PDG.

Behavioral economics is the study of the psychological factors involved in the decisions of individuals or institutions, and how these decisions deviate from those implied by traditional economic theory.[7] This includes cognitive and social factors. It also combines economic theory and psychology to explain why people make irrational decisions. Behavioral economics takes into consideration the concepts of bounded rationality, social preferences, and cognitive biases to explain why decisions made by agents often do not align with those in traditional economic theories or are suboptimal in their outcomes.[8]

Methodology and Approach:

To dive deeper into the connections between game theory and behavioral economics, I will first conduct a literature review of the existing behavioral and social modifications of game theory by consulting secondary material, acknowledging the limitations and value-adding capabilities of my research.

Afterwards, I will analyze the data obtained from a primary method, which is a survey on game theory and social norms. The survey obtained 80 responses, with respondents coming from a variety of backgrounds, though mainly concentrated in Singapore, such that I can utilize this data to analyze the impacts of different social norms on decision-making in the PDG. Various age groups from age 14 to 70 and above are involved, too, for a better representation of demographics. In the online survey that was conducted, the classic PDG is explained in simple terms to the respondents, where their decision on whether to cooperate or to defect is recorded. Afterwards, it was explained to the respondents that regardless of their choices, the rational theory given by mathematical deduction was to defect, aiding them to understand the PDG and the NE. Then, additional contexts and variations of the original situation were given to respondents regarding the PDG, such as contexts involving concepts of reciprocity, empathy, social pressure, relationships, and quality of life, all of which are altered based on social norms and are not accounted for in the traditional formulation. Data obtained from these questions will then be used for analysis of social norms' impacts on decision-making in later sections, which aids understanding of the issues of game theory and how they could be potentially solved by incorporating behavioral economics.

In this essay, I will argue for the reasons and ways to incorporate social norms and cognitive biases into the typical PDG, such that this model provides a more accurate simulation of players' decisions in real-life business and social contexts. PDG is selected as it is a classic and representative game of game theory. This will be done by carrying out the methodology stated above. Afterwards, I will evaluate the impact of behavioral factors through statistics available, before concluding on their implications and limitations in real-life contexts. The connection between social norms and game theory, as well as the codification of norms, will be addressed, too. The paper ends with a balanced summary, as well as potential avenues for future research. This essay sets the main social context in Singapore, with other societies as supporting examples.

Literature Review

Rationality and Game Theory:

There are multiple ways of categorizing rationality, the most common types being structural, substantive, bounded, and instrumental rationality. While they are all applicable in game theory to some extent, structural rationality serves as the baseline of most models, referring to the coherence and consistency of individuals' decision-making and the identifiable patterns that emerge in their choices. This is contrasted with substantive rationality, which emphasizes normative behavior.[1] This concept of structural rationality is applicable in game theory, as players are assumed to follow logical reasoning, where, for instance, one would choose an option that maximizes their own outcome, which is seen as a coherent move. However, classical formulations of rationality have been challenged by scholars who argue that they fail to capture social and ideological dimensions of decision-making. For instance, ideology itself shapes perceptions of available strategies and payoffs, influencing outcomes not predicted by models.[9] Various types of rationality can be argued to apply in game theory to different extents, as game theory itself has inherent presumptions of rationality. Building on this foundation, it is crucial to examine how these traditional notions of rationality fall short in capturing the complexities of real-world decision-making.

Critique of Rationality:

However, rationality in game theory faces limitations. For example, it does not consider fairness and social norms in the Ultimatum Game, where players often share instead of ending up in the NE.[10] It also neglects emotions, cultural differences, and social norms.[11, 12] Furthermore, people may act in a way such that we obey social rules, but we may not actually believe in it, and it is merely a mindset or values that society believes in,[6] where we are forced to do so to fit in, then it does not directly fit into any type of rationality mentioned. Cooperative strategies in repeated games often emerge even

without external enforcement, suggesting norms and reputational concerns reshape payoff structures.[13] It is challenging to simply categorize complicated human beings into a few types of rationality,[14] and something will fall out of these categories. This restricts the scope of the definition of rationality since people from various cultural backgrounds often do not subscribe to a universal conception. My research addresses this gap by incorporating these cultural and normative factors into game-theoretic analysis and by providing original empirical evidence from Singapore's unique socio-cultural context. By systematically examining how social norms operate within a multicultural society, it extends existing models beyond abstract theory to demonstrate how cultural variation in Singapore's unique demographics impacts game theory models.

Behavioral Game Theory and Its Limitations:

Behavioral game theory builds on traditional game theory to explain experimentally observed violations and human cognitive limitations,[2] by reunifying psychology and economics through the addition of social utility functions, initial conditions, and learning theories into the traditional game theory model. For example, in the PDG, players could hold emotions like hatred towards others, and are willing to sacrifice their own earnings to punish others by cooperating about half the time. This is contrary to the traditional NE, where players end up defecting in the pursuit of self-interest. Players may also only cooperate when knowing the other does so to ensure a better outcome. This makes use of social motives like hatred and fairness, which were left out in the traditional model, enhancing the model to be more inclusive towards general social norms. Experiments also show that cultures affect how Americans and Machiguenga behave differently in the Ultimatum Bargaining Game, where the Americans offer half and reject low offers, and the indigenous Machiguenga offer 15-25% and only reject one offer.[2] This shows that individual behavior depends on moral or fairness norms and social expectations.

To further illustrate, trust games reveal that players are more cooperative than game theory predicts. While models expect investors to offer nothing and trustees to return nothing, experiments show investors risk about half their money and trustees pay back slightly less than what they originally gave.[2] This illustrates reciprocity and inequality-aversion mindsets that players have instead of purely pursuing self-interest. Behavioral deviations can also be better explained when conditional preferences dependent on beliefs about others' expectations are incorporated into models, underscoring the role of normative expectations.[15] My research addresses these aspects with respect to Singapore's context, a setting that remains largely underexplored in existing literature, which primarily focuses on Western contexts or comparisons between Western and non-Western settings.

Behavioral models such as Quantal Response Equilibrium (QRE) and Experience Weighted Attraction (EWA) are also more inclusive of human behavior. QRE accounts for errors in choices and takes greater consideration of bounded rationality, where rationality is limited during decision-making. EWA assumes that each strategy has a numerical attraction, which determines the probability of choosing that strategy, and which can be applied to forecasting and other fields. These models are more reflective of humans' cognitive limitations and use statistical approaches to quantify spontaneity in decisions, providing a more conclusive model that applies to real-life situations.

From this, it is evident that while existing materials and research do have an extensive reach into behavioral aspects of game theory, and there is a growing receptivity towards social norms and behavioral economics, they are often focused on humans' moral considerations and capability limitations. They lack deeper perspectives specific to different cultures, especially in the modern-day context. I contribute by providing primary data from Singapore's context, analyzing how habituated cultural mindsets and beliefs from one's background eventually become culture. While acknowledging that such a notion exists, I will be substantiating it with a more refined analysis of culture, focusing on the formulation of cultures through one's background.

Impact of Social Norms & Culture on Traditional Formulation of Game Theory:

Cultures' impact on game theory was categorized into five sections, including intra-individual consistency, inter-agent consistency, contextual effects, behavioral stickiness, and suboptimal behavior.[16] They argued that cultural behavior emerges when agents play multiple or repeated games, instead of examining isolated, context-free environments in traditional game theory. They also highlighted how different cultures play the same game differently, depending on their experiences of other games. For example, one community played games that involved tit-for-tat, while another played games that developed a pattern of selfishness. When they play the same game, their strategies reflect their past experiences, explaining the suboptimal behavior of players and how cultures are portrayed in the form of experiencing different games, causing players' decisions to differ.

Social norms' impacts on game theory may include identity assertion and group cooperation. For identity assertion, they considered a social norm where a group values punctuality. A person might arrive on time not because it maximizes personal payoff, but because it shows that they are committed to the group. Traditional game theory struggles to explain this, as it expects decisions to be driven by tangible outcomes. In the case of cooperative behavior, like in the PDG, traditional game theory shows that rational individuals will often defect, leading to a worse collective outcome. However, social norms of cooperation can encourage cooperation, which is again difficult to explain in classical game theory. Prior attempts were made to account for social norms as belief-based systems that influence individuals' decisions indirectly, where norms function through mutual expectations rather than direct utility maximization. However, these accounts still face limitations, particularly in explaining the self-reinforcing nature of norms. Individuals may follow norms because they internalize the belief that doing so is part of their identity, not necessarily because they expect a specific future payoff. This is shown by

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how social learning and cultural evolution embed norms across generations, producing patterns that reshape equilibrium selection.[17] Norms may also function as structural mechanisms that organize social interaction, shaping both expectations and sanctioning processes to stabilize group-level cooperation.

This leads me to the insufficiencies of current developments in this area, and how I can value-add to the existing materials. While these papers were insightful in determining the broad impacts of social norms and cultures on game theory decision-making, they do not include the hierarchy of social norms and the varying value assigned to different cultures and norms. This is likely because these detailed analyses were not necessary for the topics they were researching. However, this causes the full picture of how players make decisions in relation to different norms in game theory to be missing, as existing literature only captures the general scene. My approach to collecting data from surveys further expands on the existing framework and adds value in terms of how different cultures affect decisions differently based on the relative weights of these norms or behaviors in different societies. Such an approach dives deeper into how various types of norms and cultures can be drastically different in affecting decision-making, which provides a more in-depth understanding of how game theory is affected and potential solutions to this. My approach also attempts to restructure the definition of culture to include the internalization of social norms over the years, which eventually becomes a culture, thereby explaining the impacts of internalized social norms on game theory decisions in greater detail.

In this paper, I will test these hypotheses. When familial ties are introduced, the cooperation rate increases significantly as family responsibility norms carry the greatest weight. When quality of life is emphasized, respondents are inclined to cooperate. In risk-aversion contexts, respondents tend to avoid the worst outcome, making the ranking of T and R uncertain in the TRPS model. In security contexts, respondents may prefer to remain in prison, lowering the relative importance of T.

By including a variety of age groups from different generations in my survey, my approach takes into account the fact that norms are evolving instead of being static. Through responses of respondents from different generations, evolving mindsets and norms can be reflected, showing how norms and cultures change over time, allowing a more comprehensive modeling to be made in game theory. By providing the TRPS model under the Methods section as a common denominator for discussion, this research makes dialogue on this topic more accessible to all.

In summary, literature such as papers on behavioral game theory by Colin Camerer, culture and game theory by Bernard and Page, and social norms and game theory by Paternotte and Grose was used in my analysis. While they give valuable insights on the impacts of norms and cultures on game theory, they experience inefficiencies in terms of depth, scope, and a comprehensive account on this specific topic, where I will be further diving into through my own survey results and further modelling. In this paper, I will argue that when different norms are introduced, there are different degrees of influence exerted on decision-making, and they will be reflected in changes to the TRPS ranking, which will be further elaborated on in the Methods and Results sections.

Methods

Modelling Using Primary Data:

The traditional payoff matrix of game theory often achieves the aim of providing insights into players' decision-making processes and outcomes. However, it faces limitations when social norms are considered, as norms affect how people weigh different decisions. This causes players to perceive the traditional payoff matrix differently. As such, this section aims to modify the traditional payoff matrix by using the primary data collected and analyzing the impacts of different types of social norms on the matrix.

Data Collection and Analysis Method:

The data collected involves 80 respondents from ages 14 to 70 (Figure 2), where the majority reside in Singapore. As Singapore is a multicultural and multilingual society, with a large Mandarin-speaking population, I surveyed in both English and Chinese, with the English-Mandarin dynamics standing at 50-50. This is where two questionnaires were distributed in the respective languages. This better reflects the reality of demographic diversity in Singapore, where older Singaporeans or less English-fluent residents who may be more comfortable answering in Chinese can also have their views taken into consideration. This reflects the multicultural nature of Singapore and also ensures that responses can be more accurate when respondents answer in a more familiar language. As such, this approach strengthens the credibility, inclusiveness, and representativeness of the paper, featuring a wider scope of the population.

For clarification of the aim and focus of this research, the contexts applied in the data collection and analysis processes come from academic papers and literature, as well as primary data collected in the Singapore society. Contexts refer to the specific experimental variations of the PDG embedded in the survey design, which aid understanding of norms' effects by providing contextual insights. These contexts may come in for the sake of argumentation, where one should not think of them as sociological research of cultures and norms of any society. The primary goal is only to modify and expand the scope of game theory lenses, not to create sociological insights.

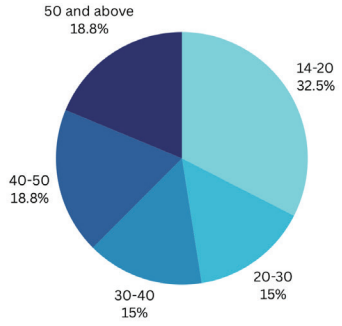

Figure 2: Age range of all respondents of the survey on game theory and social norms, with 32.5% of age 14-20, 18.8% of age 40-50, 50 and above, respectively, and 15% of age 20-30, and age 30-40, respectively.

To carry out the research effectively, considering the constraints of resources, I will use target systems in the following sections for my analysis.[19] Models often do not directly represent reality, but rather target systems, which simplify real phenomena. The target system is selectively constructed in this paper for the Singapore population to gain a useful understanding of the topics in a feasible way.

Traditional Payoff Matrix:

In game theory, for each player, the utility derived can be categorized into four types according to the matrix. This includes: Temptation for one to defect knowing that the other person cooperates (T), Reward for mutual cooperation (R), Punishment when both defect (P), and Staying silent to cooperate while the other player defects (S). The ranking in the traditional payoff matrix for PDG is T>R>P>S, where players rank their preferences for outcomes in this manner, where T is the most preferred, and S is the least preferred.[20] Referring to the PDG matrix shown in Figure 1, a player gains the least number of years in prison, 0 in this case, if he cooperates while the other defects, and hence the temptation for one to defect knowing that the other player cooperates is the highest. On the other hand, a player gains the worst outcome of 3 years of prison if he cooperates and the other player defects, making the incentive to stay silent the lowest. If both cooperate (R), this cooperation brings rewards in terms of 1 year of prison for each player, which for a rational player, is the next preferred option following the case for T. If both defects, this mutual defection brings punishments in terms of 2 years of prison for each player, which for a rational player, by the same logic, is the next preferred option following the case for R. Hence, the ranking in a traditional PDG setting would be T>R>P>S.

Results

Survey Results for the Original PDG Game:

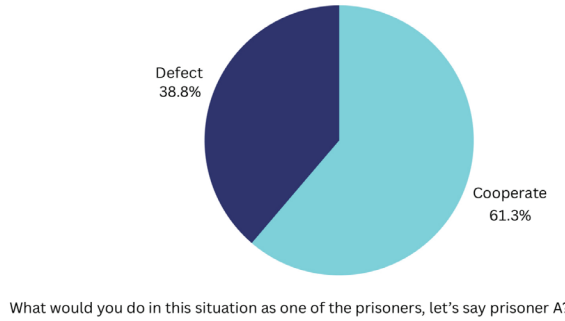

Figure 3: Survey result for original PDG, where respondents take the perspective of a prisoner, where 61.3% cooperate and 38.8% defect.

In the survey results of the original PDG (Figure 3), a majority of the respondents chose to cooperate, whereas only 38.8% chose to defect. Among the 38.8%, the T>R>P>S ranking is retained, where they are tempted to defect given the fewest years if the other player cooperates. In this case, the NE is at P, and for the player who chose to defect, the worst-case scenario is for P to occur if the other player also defects. This follows the ranking of T>R>P>S, reflecting the traditional side of game theory. Among the 61.3%, choosing to cooperate makes the best possible outcome for them to be R. In this case, the NE is still at P, but for the player, the worst-case scenario becomes S, where the other person defects, which gives him a 3-year sentence. This is seen as an intermediate resolution, reflecting the other side of game theory, which is epistemological game theory. Despite the difference in choice between the majority and the minority, both follow the ranking, as players logically rank out their desired outcomes and act accordingly. In the majority of cases, R is chosen as the respondents are highly likely to already know what other players will do, given the social norms. This is where they presume that others will answer irrationally and answer according to habits, experiences, and culture. In such a case, defection is largely disfavored by respondents as it is perceived to contravene prevailing social norms. This causes ⅔ of the respondents to choose R instead of T, since assuming that the other player chooses cooperation, cooperating too obeys the social norms better, and it also brings an acceptable outcome of a 1-year sentence. While they can choose T and disobey social norms, most respondents avoided this option. This shows that in the epistemological case, while the ranking of T>R>P>S remains, people tend to choose the intermediate R instead of T. In either case, R is still more optimal than P.

In this PDG game, it is intuitive to the players, even without much prior understanding of the PDG, that S is the worst-case scenario for a player, since he has both disobeyed the social norms and gotten the longest jail time. Similarly, the position of T in the rank mostly does not change as well, given how it most certainly brings the least number of years in prison. It is R and P that may change in their sequences in the cases we explore later, due to the effects of different social norms and how players weigh them differently.

Survey Result of Game Involving Familial Ties:

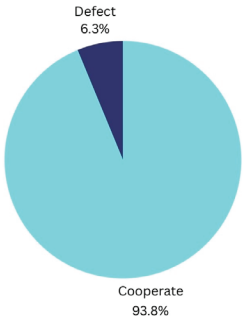

Figure 4: Survey result of PDG involving familial ties when respondents take the perspective of a prisoner, where 93.8% cooperate and 6.3% defect.

In the next part of the survey, I introduced different social norms on top of the traditional PDG settings to analyze how the traditional ranking changes. One key modification involved a close family member. In Figure 4, 93.8% of the respondents chose to cooperate, and only 6.3% chose to defect, when asked "what would you do if the other prisoner is a close family member, let's say your mother?" This overwhelming cooperation reflects norms such as filial piety and familial ob-

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ligation, especially salient in Asian societies like Singapore.[21] Cooperation aligns with this norm, as the result either lies in R or S. In the case of S, the player cooperates while the family member defects, reflecting a willingness to sacrifice their own freedom for their loved ones. In the case of R, mutual cooperation is preferred based on expectations of reciprocal care. Most players prefer R to S, as it satisfies both commitment to the norms and mutual protection. As such, R>=S, as the player is likely to expect that the family member has a responsibility to protect them, though some may value sacrifice regardless of return, suggesting R=S for them. In this case, P may be the worst-case scenario, as both players violate familial norms and imprisonment still occurs. T might be slightly better since at least the family member did not betray the norm. However, there is insufficient information for T and P, and hence we can only conclude that T>=P. Overall, the ranking becomes R>=S>T>=P. While the minority of 6.3% defected, it could be due to selfishness or strained relationships. Traditional economics mistakenly equates rationality with selfishness, assuming that people always act to maximize their own welfare.[22] Consider this as Case 1. However, he shows that people can also act out of sympathy or commitment. Consider this as Case 2. Case 1, which mentions selfishness lies in the minority choices of this question in my survey, is the situation where "rational fools" can lead to morally questionable outcomes, even though the decision to defect may seem rational when pursuing self-interest. Case 2 on commitment aligns with the majority decision of this question, which is also supported by Sen's argument, since players acted out of love and commitment, showing that the norm of caring for loved ones causes decision-making to be followed by the majority, leading to the changes in TRPS ranking. This shows that selfishness can alter the rational basis of behavioral economics theory. Furthermore, this percentage is almost negligible and is the exception, and due to insufficient data, I will not be analyzing this group of responses further.

Survey Result of a Game Involving Different Qualities of Life:

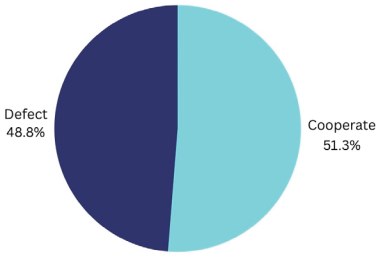

Figure 5: Survey result of PDG involving Singapore's prisons when respondents take the perspective of a prisoner, where 51.3% cooperate and 48.8% defect.

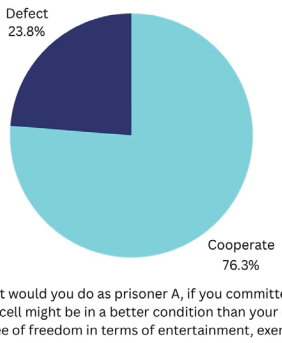

Figure 6: Survey result of PDG involving Norway's prisons when respondents take the perspective of a prisoner, where 76.3% cooperate and 23.8% defect.

Another modification explored the effect of prison conditions. Two similar questions were asked to determine the differences in players' decisions when the conditions of the prisons are different. The former involves committing the crime in Singapore and serving sentences in a Singaporean jail with harsh prison conditions or caning, whereas the latter involves committing the crime in Norway, where the prison cell is in good condition, and prisoners are able to retain a large degree of freedom. Referring to Figures 5 and 6, it can be observed that 25% more respondents chose to cooperate in the Norway setting compared to the Singapore one. This shows that with the norm being concerned about the quality of life, more respondents are willing to stay in a Norwegian jail than a Singaporean one. I will only be analyzing the 25% difference in the responses, as it is more valuable to evaluate this prominent change in responses compared to analyzing the two sets of responses separately due to the limitations of experimentation in this research, which I will elaborate on later in the following sections.

In Singapore, respondents would likely avoid S, since it brings the longest sentence. Due to the harsh conditions mentioned to the respondents, they may not even consider the other player's decision and strongly aim at avoiding S, due to the harsh consequences.[23, 24] In Norway, where jail is far more comfortable,[25] S is no longer the worst-case scenario for the player, since the quality of life is fairly bearable and tolerable. P might be the worst-case scenario, since the player would have violated the cultural norms of loyalty, trust, and integrity by defecting, and still get a 2-year sentence. This makes the ranking change to T>R>=S>P when the Singapore setting is changed to the Norway setting. T would remain optimal to the player, as freedom retains intrinsic value even under improved conditions.

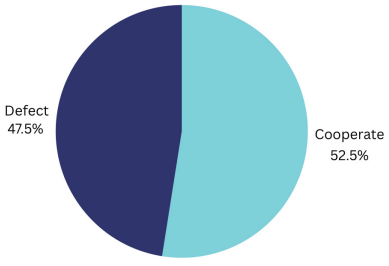

Figure 7: Survey result of PDG involving pregnancy when respondents take the perspective of a prisoner, where 52.5% cooperate and 47.5% defect.

Another modification involves risk aversion. In Figure 7, 52.5% chose cooperation while 47.5% chose defection. Pregnant respondents may seek to avoid imprisonment due to risks such as injury or lack of support. Research suggests that psychological and physical changes during pregnancy may cause risky decisions to be avoided more.[26] To clarify, although the cited paper may include stereotypical representations of women during pregnancy, the analysis of the data in this question refers only to one specific decision-making pathway observed among pregnant women.[27] As highlighted in section 3.2, the aim of this research is not to provide an exhaustive account of all possible strategies but rather to examine this particular pattern in detail. As information on alternative decision-making approaches is unavailable, the relative ranking of T and R is indeterminate. Within this particular framework, the risks posed to the players motivate prioritizing leaving prison, causing them to rank T highly, because it guarantees the least prison time, which allows them to avoid the harsh prison conditions, following the norm of risk-aversion. However, uncertainty about T and R may persist due to imperfect information, explaining the 47.5% who defected. P and S will likely remain the worst, as they bring the most number of years, and S also causes them to break the social chord of risk aversion. In this case, the sequence of TRPS remains the same.

Survey Result of Game Involving Immediate Needs and Security:

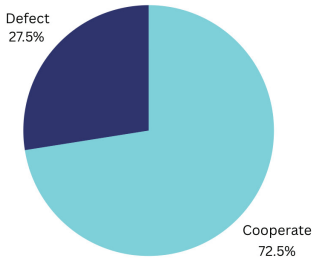

Figure 8: Survey result of PDG involving poverty and homelessness when respondents take the perspective of a prisoner, where 72.5% cooperate and 27.5% defect.

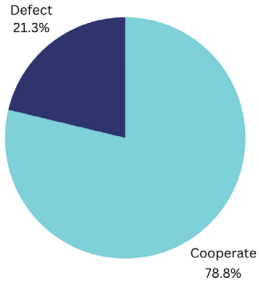

Figure 9: Survey result of PDG involving artists when respondents take the perspective of a prisoner, where 78.8% cooperate and 21.3% defect.

Lastly, the modification is grounded in the concepts of immediate needs and security. For this, I will be analyzing the results of responses for the two questions in Figures 8 and 9, as they involve similar social norms and provide insightful details collectively. In Figure 8, 72.5% chose cooperation while 27.5% chose to defect. In Figure 9, 78.8% chose cooperation, while 21.3% chose to defect. For Figure 8, the cooperation rate is high because of how people suffering from poverty and homelessness may have the immediate and desperate need to find a shelter, a place that provides food and necessities. Research showed that indigenous people value basic needs more, proving that in less-ideal circumstances, immediate concerns are more heightened than other goals, such as long-term impacts of confinement. This aligns with how those suffering from poverty may value urgent needs much more highly.[28] This reflects the norm of seeking environments that fulfil their immediate needs and provide security. In fact, in Asian societies, certain people suffering from poverty even commit crimes to purposely enter jails for the necessities and security, proving that they may even prefer prison conditions out of desperation.[29] Similarly, for Figure 9, which has a similar cooperation rate, an artist creating paintings may value the prison environment for providing a period of time for them to create their paintings without disturbance from work or other obligations. In these two cases, cooperation is preferred by a majority of the respondents because the players are willing to spend more time in prison due to the above-mentioned reasons. This suggests that T is not prioritized as it is in the traditional theory, since the social norm of seeking instant security and fulfillment of needs is followed by players, causing them to favor strategies that allow them to stay in jail for a longer period of time. While this shows that T is not the most favorable option, its exact position in the ranking is unknown, as the ranking of R, P, and S may vary largely depending on individual thinking and decision, causing the ranking to be indeterminate. Hence, this data is only able to show that this specific norm changes the position of T. While 21.3% defect, this is the minority, which could be because the players still value freedom extremely highly. Certain artists may also think that they will not thrive in captivity and gain inspiration from having freedom, such as through being in nature or having exposure to other artwork. For them, the TRPS ranking may remain.[30]

Discussion

Differing Value for Various Social Norms:

From the four types of norms established, including familial ties, quality of life, risk aversion, and immediate needs and security, we can observe the differences in how they affect the traditional TRPS ranking. For the game involving Norwegian prisons (Figure 6), the game involving poverty and homelessness (Figure 8), and the game involving artists (Figure 9), they have cooperation rates of 76.3%, 72.5%, and 78.8%, respectively. The similar cooperation rates suggest that players in my survey value quality of life and immediate needs, and security, similarly, assigning similar significance levels to these two norms. This is logical, as these two norms are all centered

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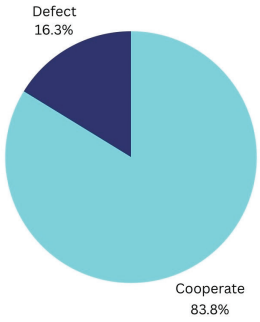
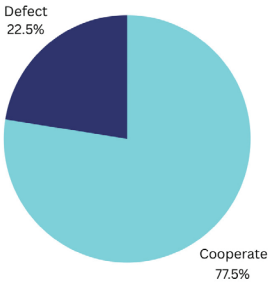
around one's own needs, such as comfort, desires, and pursuits. For the situation involving familial ties (Figure 4), 93.8% of players chose to cooperate, showing that the norm of having pure altruism for loved ones carries the highest weight among the other types of norms. This also reflects the reality of decision-making, where players in my survey value their loved ones' well-being more than their own. In situations involving dire consequences (Figure 5) and risk-aversion (Figure 7), it can be seen that 51.3% and 52.5% chose cooperation, respectively. This shows that players weigh norms involving consequences or risks the least among the norms. As such, we can observe that various social norms have different levels of significance in the decision-making processes of players. Thus, this reflects the limitations of existing literature on social norms and cultures again, as they do not account for the different values of norms for the benefit of their own papers.

Constraints of Research and Summary:



In the same situation, what would you do as prisoner A, if your society despises people who betray others – say it is fine to stab betrayers to death out in the open?

Figure 10: Survey result of variation of PDG when respondents take the perspective of a prisoner, where 83.8% cooperate and 16.3% defect.



In the same situation, what would you do as prisoner A, if you and prisoner B will be assigned in the same prison cell if both of you have to serve a sentence?

Figure 11: Survey result of another variation of PDG when respondents take the perspective of a prisoner, where 77.5% cooperate and 22.5% defect.

However, I would also recognize the constraints and limitations of this research. Firstly, due to the lack of resources and capacity to conduct experiments, the primary data collected is in the form of a survey. This could be limited since I can only analyze and assume the decision-making processes of the players, as well as the norms. However, while there is no specific mention of the norms, they are more implicitly built into the questions, which allows me to analyze their responses critically and understand the effects of norms on them. The lack of data and information also leads to unknown norms of some questions in the survey, limiting the extent to which I can analyze their responses, which is why I excluded certain scenarios in my research. For example, Figures 10 and 11 were not analyzed in detail, as they lack data on the implicit norms, and the norms are also not obvious; hence, I am unable to conclude that players are likely to consider certain norms during their responses. Based on the data available and missing information on norms, I am only able to assume that in these cases, the traditional TRPS ranking is followed, which provides little valuable insight. However, from the variations I analyzed, I was already able to draw insights into the relative weights of norms and their impacts on decision-making.

Due to the limitations of the software used to compute percentages through pie charts, I would also like to clarify that the percentages of cooperation and defection may not add up to 100%, but may be slightly more than 100%, as the software rounds up the decimal places of cooperation and defection individually.

The survey sample was created through voluntary participation, with respondents recruited via online distribution channels accessible to a wide demographic. While the sample was not probabilistic in the strict statistical sense, it aimed to approximate diversity by including participants from multiple age groups and linguistic backgrounds. All responses were collected and analyzed in compliance with ethical standards in social science research, where participants were informed of the purpose of the study, assured anonymity, and confidentiality of their responses.

Overall, the data collected shows how the traditional ranking of TRPS is challenged when norms are implicitly taken into consideration. It can also be observed that various norms have different values when respondents consider them in decision-making in the PDG.

Constitutive Connection Between Norms and Game Theory:

The previous sections have established that norms are a constitutive part of game theory, particularly the PDG, which was analyzed. From existing research papers, it is shown that different cultures, such as indigenous groups, could be less influenced by social motives, reciprocity, and inequality-aversion mindsets, and cognitive constraints have also been taken into consideration by EWA. This proves that social norms have an impact on game theory, and some have modelled these impacts to make more inclusive models. My research analyzes how implicit social norms based on different cultures lead to different significance of varying norms when players make decisions. It can be seen that by understanding the changes in the TRPS ranking, norms, including familial ties, quality of life, risk aversion, and immediate needs and security, have different significance when players make decisions in the PDG setting. It can be observed that in Singapore's society, familial ties have the highest significance due to the greatest deviation in the TRPS ranking, reflective of the filial piety in Singapore. This has a significantly more distinct impact compared to other norms, such as risk aversion. This shows that norms cannot

be discussed and viewed as a collective aspect, but should be viewed distinctly, as each norm may have a different impact on game theory. The varying extent of impact on decision-making emphasizes the importance of analyzing and incorporating norms into game theory, so that they can be applied to wider contexts.

Codification of Norms in Survey:

Norms can come in implicit or explicit ways. In "Nudge" by Richard Thaler and Cass Sunstein,[31] experimental results show that among various types of information given to taxpayers to incentivize tax compliance, only one method worked well. It was when the taxpayers were told that 90% of those in their state had already complied in full with their obligations under the tax law. This is a form of an explicit norm, where people are explicitly told about the norm, and hence they are pressured to follow it.

However, social norms are often more implicit than explicit. In the Outline of Theory of Practice,[32] it was shown that through habitus, people internalize norms unconsciously from their social environment. They act in ways that "feel natural" without being taught formal rules. This notion is also apparent in my research, where norms are implicitly embedded in practice and not openly stated. This is done by phrasing the questions in such a way that respondents act according to implicit norms when answering. For example, in the situation involving familial ties, respondents largely chose to cooperate, as it is an implicit norm to prioritize the well-being of their loved ones, which guides their behavior subtly, not through explicit instruction. In the situation involving quality of life, the norm may be even more codified, as chasing a better quality of life may be more intrinsic. The extent of codification of norms may vary for different contexts, but this codification occurs not only for single norms, but for norms as a whole. This codification allows respondents to make decisions in PDG without having to consider the norms, but they are built in. This allows the variations of PDG to be analyzed, as the responses are based on the norms with no explicit mention, avoiding leading questions, and allowing for more accurate analysis of the data. It also emphasizes the importance of studying social norms in game theory, as they are always present when players make decisions and cannot be ignored.

Decision-making Based on Norms:

In the data, it can be observed that players make decisions based on norms as heuristics, even when they have been provided the NE in the original PDG, as mentioned in section 1.5. This is where the respondents were told that "regardless of their responses, the solution that players will choose in an ideal rational world would be to both defect, as they would both want to go free, but end up with a 2-year sentence each. This is because no matter what the other person does, each prisoner gets a better outcome by defecting. If B cooperates, A should defect because going free is better than serving 1 year. If B defects, A should also defect because serving 2 years is better than serving 3. So, in both cases, A's best choice is to defect regardless of B's strategy. The same reasoning applies to B, so both prisoners will end up defecting. However, they could have yielded a better result if they both cooperated and yielded a 1-year sentence." This indicates that players do not necessarily prioritize utility-maximizing strategies when faced with social or moral considerations. Instead, their behavior reflects a tendency to conform or follow expectations such as reciprocity and risk aversion. They make these decisions through mental shortcuts presented by the internalization and codification of social norms. This deviation reflects that incorporating norms into models could significantly improve the reliability of such models, especially in real-world strategic interactions where trust, cooperation, and norms matter.

■ Conclusion

This research paper first studied the concepts of rationality used in game theory, acknowledging its limitations in scope and inclusivity. Then, I discussed existing literature and its implementation of norms and behavioral aspects, while using primary data and analysis to explore the varying impacts of different norms on decision-making, which is missing from existing work. Afterwards, I elaborated on the primary data collected in Singapore, categorizing the responses into different categories of norms. I showed that social norms significantly influence decision-making in the PDG, causing deviations from the traditional TRPS ranking. Different norms, such as familial ties, quality of life, risk aversion, and immediate needs and security, carry different weights, with familial ties having the strongest impact in Singapore's context. This highlights the importance of analyzing norms individually instead of collectively, and incorporating them into game theory to better reflect real-world decision-making. Social norms in my survey are implicit and internalized, aligning with existing literature. The survey questions are also designed so that respondents unconsciously follow these norms without explicit awareness. This implicit codification allows respondents to make natural decisions in the PDG, enabling a more accurate analysis of how norms affect behavior. The research underscores that social norms are always present in decision-making and should not be ignored in game theory models.

This research has limitations due to the constraint of relying on survey data instead of experiments, which restricts the analysis to interpreting players' decision-making and implicit norms. Some scenarios also lack clear information on norms and were excluded from detailed analysis. Despite this, the study still provides valuable insights into how norms influence decision-making. While the sample size could be small, rigorous inclusion criteria of a smaller context ensured that the sample was highly relevant and representative of the target population. The findings are also consistent with prior research and evidence provided, which supports their validity despite the limited sample size. Future studies with larger samples are encouraged to further validate these results. While my methodology is not as controlled as existing frameworks, it understands society as a whole and modifies the existing sequence of game theory. The deeply reflective questions of experiences

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that are tangible and accessible to participants raise the significance of my research further.

As discussed above, social norms are deeply embedded in decision-making in game theory. It also cannot be ignored since it is internalized, and each norm carries varying weights. This leads to many potential avenues of future research. It can include further and deeper research on the varying significance levels of norms in a controlled environment with more experimental resources, and using norms from different cultures. This could be comparing cross-cultural behavioral responses in other games, such as coordination games and trust games. Furthermore, this field also has many opportunities in modelling norms into game theory models. Prior attempts to integrate social preferences into utility functions provide a foundation for developing mathematical and philosophical frameworks that explicitly model the perceived value of norms within payoff structures, including both material payoffs and normative components. Future research could build on existing cross-cultural experiments and extend these approaches to explore how such differences influence strategic behavior. This would allow a more comprehensive view of game theory to be achieved in social contexts, allowing it to be more widely applicable to less mathematical fields.

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Authors

Zhang Yiran is a committed researcher and student at Dunman High School, with a passion for behavioral economics and game theory. Her work navigates the intricate connection between the two fields through the lens of norms. Apart from academics, she also enjoys musicals and is actively engaged in school projects.

Annex A: Survey questionnaire

- What is your age range?

Some context: What is the Prisoner's Dilemma Game (PDG)?

The Prisoner's Dilemma is a situation in which two people are faced with a choice: cooperate with each other or defect (testify against the other). Here's how it works in simple terms:

- Two prisoners A and B are arrested for a crime. The police have enough evidence to convict them on a charge, but with missing information on the specific duration of the charges that should be charged.
- Each prisoner has two options:

1. Cooperate (stay silent and not betray the other).
2. Defect (testify against the other).

If both cooperate, they get a 1 year sentence each. If both defect, they get a 2 years sentence each. If one cooperates and the other defects, the defector goes free (0 year sentence), and the one who cooperated gets a 3 years sentence.

- What would you do in this situation as one of the prisoners, let's say prisoner A?

Regardless of your response, the solution that players will choose in an ideal rational world would be to both defect (fyi, this is called the Nash equilibrium), as they would both want to go free, but end up with a 2 years sentence each. This is because no matter what the other person does, each prisoner gets a better outcome by defecting. If B cooperates, A should defect because going free is better than serving 1 year. If B defects, A should also defect because serving 2 years is better than serving 3. So, in both cases, A's best choice is to defect regardless of B's strategy. The same reasoning applies to B, so both prisoners will end up defecting. However, they could have yield a better result if they both cooperate and yielded a 1-year sentence. From this, we can observe that the decisions of players may not always be optimal for themselves.

However, people do not always make decisions in this manner, as there are often more considerations to make in different contexts. To examine this, I would need your help to answer the following questions. There is no right or wrong, so just choose based on your actual opinions, life experiences, and notions of what is ethically or culturally right!

- In the same situation, what would you do as prisoner A, if prisoner B is a close family member of yours, let's say your mother?

- In the same situation, what would you do as prisoner A, if your society despises people who betray others--say, it is fine to stab betrayers to death out in the open?

- In the same situation, what would you do as prisoner A, if you and prisoner B will be assigned in the same prison cell if both of you have to serve a sentence?

- In the same situation, what would you do as prisoner A, if you committed the crime in Singapore, where you might also face caning and harsh prison conditions if you stay in prison?

- In the same situation, what would you do as prisoner A, if you committed the crime in Norway, where the prison cell might be in a better condition than your own house, and you still preserve a large degree of freedom in terms of entertainment, exercising and socialising?

- In the same situation, what would you do as prisoner A, if prisoner B is suffering from a serious disease and might only have few years to live?

- In the same situation, what would you do as prisoner A, if your society have poor rehabilitation programmes and employment becomes a challenge after you finish serving your sentence?

- In the same situation, what would you do as prisoner A, if you're pregnant?

- In the same situation, what would you do as prisoner A, if you know that you bear a larger responsibility than prisoner B for committing the crime? (For instance, you were the one who planned and executed the crime in its entirety while the other person just happened to be there at the scene of crime. The police have therefore arrested the other prisoner as an accessory to the crime although they had no intentions of committing it themselves. Only you and the other person know this, no one else.)

- In the same situation, what would you do as prisoner A, if you're an artist creating paintings and you know for sure that someone will buy, and prison gives you the leisure time to paint? (Assume that you have little time to do so on normal days)

- In the same situation, what would you do as prisoner A, if both of you initially agreed to cooperate even before committing the crime?

- In the same situation, what would you do as prisoner A, if you suffer from poverty & homelessness?

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