Master's Thesis of Economics

What kinds of people prefer cooperation?

협력을 선호하는 사람들은 어떤 사람인가?

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Abstract

What kinds of people prefer cooperation?

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This thesis determines to analyze what kinds of people choose cooperation strategy, especially the relationship between individual characteristics, cooperation, and total payoffs in infinite repeated prisoner's dilemma games [①], figuring out the motivations of cooperation in infinitely repeated prisoner's dilemma games. A comparison of the game in terms of Nash equilibrium with respect to the theoretical best responses and empirical outcomes.

Keywords: repeated game; game theory; prisoner's dilemma; risk attitudes; individual characteristics

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[①] Repeated prisoner's dilemma game with error term E=0 in this paper, and I also conducted the dictator game and mixed motive game (snowdrift game) by o-tree. Using the Tobit regression and ordinary least square regression between repeated prisoner's dilemma and dictator game (DG), all of outcomes show non-significant in statistics ($p>0.1$), comparing to all of treatments. Therefore, the outcomes relate to DG was deleted in this paper. The lack of significance may be owing to certain mistakes that occurred when I was playing the dictator game, even if they are not necessarily logically significant.

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Chapter 1.
Introduction

Reference dependence is a key concept in behavioral economics and prospect theory deviations from the anticipated utility theorem (EUT) associated with loss aversion and the endowment effect in decision-making (Kahneman 1991). Understanding whether individual characteristics influence cooperation rate is crucial for both social science and economics, knowing how to work with others in difficult situations is a crucial life skill in both urban and rural settings (Anna Dreber 2014). Lab tests have shown that once people have played a game a few times, the percentage of them who cooperate depends on the payoff parameters. For example, Dal Bó and Frechette (2013), Rand and Nowak (2013), and others have shown that cooperation is much more common when the payoffs are higher, and the future is further away. This begs the question of who these cooperators are, whether they differ in other ways from the game players who defect, and whether these differences vary with the benefits of cooperating. This study investigates player behavior in the repeated prisoner's dilemma game (RPDG), as well as players' motivation to collaborate or not in repeated games.

The relationship between risk attitude and cooperation in the RPDG remains an open question in Dreber (2014), my work tends to figure out the relationship between cooperation and individual characteristics, especially risk attitude in both prisoner's dilemma games. Also, it tends to figure out the relationship between total payoff, and individual characteristics.

What causes individuals to make distinct choices in the endlessly repeated game? One of the hypotheses is that the heterogeneity would tell us the answer. Previous research by Fudenberg et al. (2012) did the related prisoner's dilemma game and dictator game to illustrate who cooperates in the repeated games. Players would cooperate or defect in each round, and players may change their strategy when the other player makes a different decision. It means that players would

likely be similarly influenced by the other player's choices. As shown in Dreber (2014), selfishness promotes cooperation rather than inhibits it, and apart from the grim trigger and constant defection, players in RPDG cooperate for the long-term maximum earnings and morality right. However, it remains an open discussion about whether risk attitude influences cooperation. According to Andreas and Benjamin (2012) answered a part of this question, and in contrast to Sabater-Grande & Georgantzis (2002), risk aversion does not promote defection while boosting cooperation if the environment is cooperative-friendly.

Understanding the heterogeneity of play appears valuable for predicting when cooperation will emerge, and for the debate regarding the role of other-regarding or "social" preferences in promoting cooperation. Specifically, the data pose the question of whether the motivations of the cooperators extend beyond maximizing their own financial gain. Although other-regarding motivations play a significant role in generating cooperative behavior in certain interactions, the extent to which they influence play in infinitely repeated games is mainly unknown.

As a first step toward comprehending the origins of heterogeneous play and the way subjects respond to alterations in in-game parameters, I conducted a series of experiments. This paper demonstrates what kinds of agents cooperate and what kinds of motivations for participants to cooperate in infinitely repeated prisoner's dilemma games with online experiments and databases using repeated prisoner's dilemma models, concluding that game players cooperate in infinitely repeated games due to the long-term maximum payoff they will receive, and the relation between heterogeneity and total payoffs. Changing the parameters of the independent variable to comprehend the meaning of heterogeneous games, especially the prisoner’s dilemma game.

Intuitively, subjects who have risk-aversion characteristics would promote cooperation rather than yield defection if it is under non-cooperative treatment and the most powerful motivation is to earn the largest money in the long run of this experience. My experiment

contributes to these questions about strategic interactions in infinitely repeated games to figure out specific evidence.

Chapter 2.
Theoretically framework

This paper analyses the strategic interaction on cooperation in repeated games, what kinds of game players play cooperative action, whether social preference and heterogenous facilitate cooperation or not, and the relations between individual characteristics, cooperation, and non-cooperation treatments.

The theoretical framework of an infinitely repeated game consists of a pool of game players (n>2), in the infinite time period (t=1, 2, ..., ∞) to cooperate (C) or defect (D) at the same time for gaining payoff and it will end by a probability of continuation $\delta \in$ (0, 1). Each of the game players could only choose to cooperate or defect in one time. Payoff matrix for representative game players i and j, the standard prisoner's dilemma format as below (Table -1-).

	Cooperate	Defect
Cooperate	(x-c_i, x-c_j)	(-c_i, x)
Defect	(x, -c_j)	(0, 0)

Table -1- standard prisoner' s dilemma format

This game is about decision-making, game players were matched with other people in the experiment, and game players were divided into one group, which group has two game players. Due to reality, benefits and punishment costs would not be the same all the time, for simulating the real situations, 3 treatments were placed on all game players without noise. Game player 1 would play with player 2 only, and vice versa, they would be randomly divided into two-player groups and made the decisions independently without any communication. Before starting the game, game players were informed of the game introductions and sessions are varied by length based on

the rules of determination, while there are 5 sessions and 20 rounds on average; players played a stochastic number of rounds with a given partner in each game. Due to turnpike protocol②, the probability of continuation to the next round (δ) is 16/17, and game players could not end this game before 20 rounds. ③

There are 3 questions in this research:

Question 1: Is there a relationship between cooperation and individual characteristics?

Question 2: Are total payoffs in RPDG related to individual characteristics?

Question 3: What are the motivations for the cooperation?

To evaluate the first question, game players could only choose cooperation or defection in the RPDG with a constant probability of game continuation, and the returns to the decisions varied with four different payoff specifications. When game players cooperate at the same round more frequently, the returns to cooperation are high and they would earn higher payoffs. Game players must answer their individual characteristics through the first questionnaire, including their age, major, risk attitudes, and gender. To estimate the correlation between RPDG and individual characteristics, I run censored Tobit regressions with a dummy variable for RPDG (a binary variable indicating the game players cooperate in RPDG or not, 0 is cooperating and 1 are non-cooperate) as an independent variable, utilizing robust standard errors that are clustered by session.

Game players should complete 1 game and 2 questionnaires, including a prisoner's dilemma, individual characteristics, and motivation survey for figuring out the relations between common behaviors and cooperative decisions.

To begin with the game, game players should answer a

② Kamecke (1997) announced turnpike protocol at first and Dal Bó (2005) executed it in detail.

③ According to the rules of IRB at Seoul National University, the participants of experiment can quit this game without any reasons, while there is no one quit this experiment in the progress besides a few participants could not access to the o-tree websites at the beginning of this game.

questionnaire to provide individual characteristics about their age, gender, major and risk attitudes, and education level. It is a self-reported survey about individual characteristics including biological gender (female or male), age, major (economics or not), risk attitude (risk level; 0 is absolutely risk aversion, 10 is absolutely risk loving), and education level. Second, game players should play the RPDG on the O-tree website. To minimize the learning effect in the RPDG, each session contains five interactions.

Second, to evaluate the second question, I analyze the relationship between the payoff in the RPDG and individual characteristics with regression analysis in the non-cooperative versus cooperative treatments separately.

Third, the motivation of game players in the RPDG was analyzed in this part, they should indicate the reasons and the levels for cooperating in the RPDG. motivation questionnaire was used to figure out the specific motivations of game players in RPDG, which can explain the reasons for cooperation. Moreover, I investigate the connection between these motivations and cooperation in the RPDG. At the individual level with all payoff specifications, a large majority of subjects reported that maximizing their long-term payoff was a more important motivation for playing cooperatively than the desire to increase their partner's payoff, do the morally correct thing, or avoid upsetting their partner.

Chapter 3.
Experimental Design

The purpose of this experiment is to figure out the relationship between total payoff, cooperation, motivation of cooperation, and individual characteristics in RPDG. Find the reasons and motivations for participants to choose cooperation, which combines cooperation in a repeated prisoner's dilemma game by varying the returns to cooperation, by collecting self-reported surveys and searching for the relationships between social preference, individual characteristics, cooperative treatments, and non-cooperative treatments.

This experiment was approved by IRB of Seoul National University, and the game players were recruited through the online recruitment form. 72 game players were recruited online mainly consisting of undergraduate and graduate students (39 females, 33 males; mean age 25.09 years) from Seoul National University and other universities all over the world by using the main treatments of Dreber et al. (2013), through the community applications and social media platforms, such as WeChat, Kakaotalk, Everytime, Line and Instagram. I created open websites through the O-tree[④] software package, which is RPDG for running this experiment online and collecting the data automatically. Game players interacted independently and randomly via O-tree websites in RPDG, and they have been told that they cannot have any communication with each other. The show-up fee for each people is KRW ₩ 7000won (CNY ¥50 RMB or US $10 dollars), and players can get extra money by earning points in RPDG, where the exchange rate is 20 points = KRW ₩1000 won. All game players start with an endowment of 140 points[⑤], and they can gain from KRW ₩8000won to KRW ₩ 12,000won in total.

3.1 Prisoner's Dilemma

Fudenberg et al. (2012) first reported an RPD with an execution error. In the RPDG, each subject played a random number of rounds against a given opponent; when the current interaction concluded, subjects were rematched according to the turnpike protocol (proposed by Kamecke in 1997 and implemented in the repeated game context by Dal Bó in 2005). Participants chose between cooperation (C) and defection (D) in each round. I used the 'equal gains from switching' rule, which is formulated by unilateral moves by Dreber et al. (2008). This rule identified the benefit and cost function here so that

④ This experiment was coding via python and inserted the coding to O-tree, it automatically recorded the data made by game players via o-tree, including decision time, choices, names, payoff and so on.

⑤ There are 9 out of 72 game players got final points less than 140 points, which got minus points from -2 to -18.

cooperation meant paying a cost of c units for the other to gain a benefit of b units. There are two choices for subjects to choose from, which are cooperation (C) and defection (D). The definition of cooperation is that one person pays a cost (c) and for the other person to get a benefit (b) and the definition of defection is that one person earns a payoff (p), for the other person to lose a cost (c), while defection caused 0 points for both people.

First, to figure out the relations between the cooperation in RPDG by changing the returns to cooperation for using the straightforward b/c ration by fixing the c is 2, and 3 treatments are b/c=4, b/c=2.5, and b/c=1.5; the payoff matrixes showed to game players in O-tree website are as below (Table -2-). The cooperative treatment means that cooperation is an equilibrium in RPDG and b/c=4 treatment, and b/c=2.5 treatment have an equilibrium in cooperation. As shown in Fudenberg et al (2012), the only Nash equilibrium in b/c=1.5 treatment is "Always Defect"; thus, it is divided into non-cooperative treatment. Due to observation errors, there are no equilibria in which subjects intend to cooperate after every sequence of observations. Indeed, there are two cooperative measurements in this paper, one is the frequency of game players cooperating in all rounds, and the other is the frequency of game players cooperating in the first round; for observing the differences in learning effects and comparing how game players would change their strategies. The payoff matrixes are as below (Table -2-).

b/c=4 Other person

		Action1	Action2
You	Action1	(6, 6)	(-2, 8)
	Action2	(8, -2)	(0, 0)

b/c=2.5 Other person

You		Action1	Action2
	Action1	(3, 3)	(-2, 5)
	Action2	(5, -2)	(0, 0)

b/c=1.5 Other person

You		Action1	Action2
	Action1	(1, 1)	(-2, 3)
	Action2	(3, -2)	(0, 0)

Table -2- Payoff matrixes

3.2 Motivations in RPDG

In the motivation questionnaire, queries regarding next-round behaviors were included, and game participants were asked how they reacted based on their companions' previous responses. It contains three questions, (i) When your partner gave the points lower than you and what was your reaction, (ii) when your partner gave the points higher than you and what was your reaction, and (iii) when your partner gave the points are the same as you and what was your reaction.

The outcomes show that most of the game players followed the previous movement of their partners, if their partner gave lower points in the previous round, then most of the game players gave higher points in the next round; if their partner gave lower points in the previous round, then most of the game players gave the lower points in the next round; if their partner gave lover points in the previous round, then most of the game players gave the same points in the next round.

To investigate the cooperative motivations of game players, they conducted to complete the motivation questionnaire after RPDG.

According to the four outcomes appeal in the previous round which are CC, CD, DC, and DD, game players must choose which their motivations⑥ were to (1) maximize their own long-term points, (2) help their partner earn money, (3) feel a morally right thing or (4) avoid upsetting their partners.

Game players conducted the one example as "Remind previous round you played C while your partner played D, and you have to make a choice in this round. What is your motivation to play C in this round as (1) collecting the most points in the long-term game, (2) helping others earn more points together, (3) doing the morally right things and (4) being unwilling to upset partners. The game player indicated 7 choices from number 1 to number 7, while number 1 means "not at all" and number 7 means "very much" by making composite the sum of four situations (CC, CD, DC, DD) and the sum of four motivations.

Moreover, the importance of first-round cooperation and all-around cooperation are tested in this paper. The outcomes show that most of the game players indicated the motivation of collecting the most points in the long-term game in this research. It is consistent with the outcomes in Dreber (2014), the motivation of collecting the most points in the long-term game were the main purpose of game players to play the RPGD.

Chapter 4.
Results

4.1 Results

Question 1: Is there a relationship between cooperation and individual characteristics?

I find there are no significant correlations between the total payoffs from the RPDG ($p>0.01$ for all comparisons) and the heterogeneity from the individual characteristics. Tobit regression was placed on the heterogeneity with different individual characteristics, including

⑥ This motivation questionnaire based on the same standard in Dreber (2012).

gender, major, age, and risk attitude. The dummy variable, such as gender (female=1, male=0), an economics major or not (econ=1, non-econ=0), age, and risk attitude (0-10 lower number means lower risk taking) could predict the relationship between total payoffs and heterogeneity. Individual characteristics were conducted before RPDG, which has previously been explored by e.g., Dohmen et al. (2010). The self-report risk attitude question has been proven to be a good predictor of game players making economic decisions. Evaluate the first question, it contains the fixed variables (first round) and the control variables (all rounds) in the cooperative versus non-cooperative treatments separately in RPDG. Cooperative treatment[⑦] means cooperation is an equilibrium in RPDG, while non-cooperative treatment means cooperation is not an equilibrium. Therefore, I clean the data as four variables in RPDG, which are all round cooperative treatment, all rounds non-cooperative treatment, first-round cooperative treatment, first round non-cooperative treatment.

The reason for comparing the first-round cooperation and all rounds cooperation is that the first round represents game players' own strategy, while all rounds' interactions reflect the strategies of their partners and themselves. However, there is no significant relationship between age and major in either the cooperative or non-cooperative treatments. Figure -3- shows the relationship between risk attitude and all rounds of non-cooperative treatment significantly negatively related (p=0.074), and otherwise, nothing is significant.

In the prisoner's dilemma game, there are 72% of game players are risk-averter (0-5 risk level), and 28% of game players are risk lovers (6-10 risk level). It shows that most of my experiment participants are risk-averters and varied considerably in risk preferences (M=4.375, SD=1.88). The highest cooperation rate of risk-averter is 56% (*p=0.069) and the highest cooperation rate of risk-lover is 70% (*p=0.077) shown in Figure -4-; the mean cooperation rate of risk averter is 37% and the mean cooperation rate of risk-lover is 43.25%

⑦ Cooperative treatments contain b/c=4 and b/c=2.5, the non-cooperative treatment contains b/c=1.5 e.g., Fudenberg et al (2012).

in figure -4-. Thus, it illustrates that the higher risk-taking is, the lower the cooperative rate in all rounds in non-cooperative treatment (b/c=1.5). Conversely, the lower risk-taking is the higher cooperative rate in all rounds of non-cooperative treatment (b/c=1.5). As previous research by Fudenberg et al. (2012) the only Nash Equilibrium in b/c=1.5 non-cooperative treatment is "Always Defection" and selfish people are more likely to play "Always Defection" in non-cooperative treatment, and the cooperation rate is decreasing by treatments (see Figure -5-). In other words, people who are risk aversion type prefer choosing defection in non-cooperative treatment to get the highest profits, they show more loss aversion features than risk-loving people.

In previous findings (e.g., Andreas 2014), the results of this paper show that risk aversion yields rather than inhibits cooperation in cooperation-friendly environments. My work complements that paper, especially risk aversion boosts rather than inhibits defection in cooperation-unfriendly environments, and risk loving may boost rather than inhibit cooperation in non-cooperative treatment. Moreover, as previous research shows in Dreber et al. (2014), selfishness promotes rather than inhibits cooperation, whether risk-lover people have significant selfishness or not remains an open question.

	All rounds C		First round C	
	b/c>1.5	b/c=1.5	b/c>1.5	b/c=1.5
Gender(female)	-0.956	0.4515	-0.179	-0.116
	(-1.10)	(1.31)	(-0.92)	(0.236)
Major (Econ)	0.884	0.374	-0.421	-0.861
	(0.54)	(0.57)	(-1.14)	(0.927)
Age	-0.063	-0.085	-0.011	-0.895
	(-0.44)	(-1.48)	(-0.34)	(0.934)
Risk attitude	-0.139	-0.163*	-0.50	-0.562
	(-0.59)	(-1.74)	(-0.94)	(0.471)
Education	0.806	0.435	0.0386	0.104
	(1.12)	(1.53)	(0.24)	(0.204)
Constant	5.199	2.916***	1.473***	1.812***
	(1.49)	(2.12)	(1.88)	(0.117)
Observations	216	72	216	72
Robust standard errors in parentheses ***p<0.01, **p<0.05, *p<0.1				

Figure -3- Cooperation: Individual Characteristics (Panel)

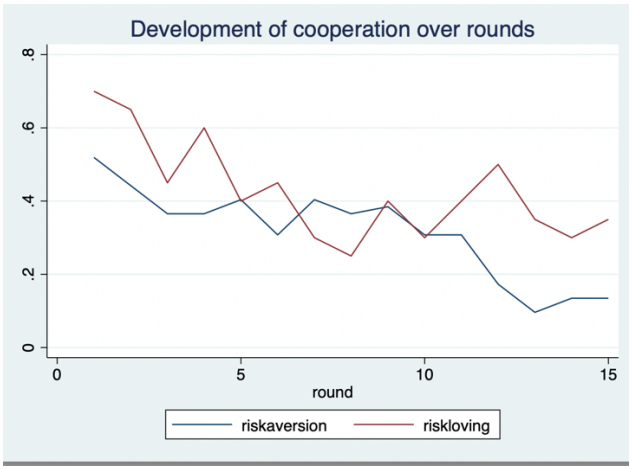

Figure -4- Development of Cooperation over Rounds

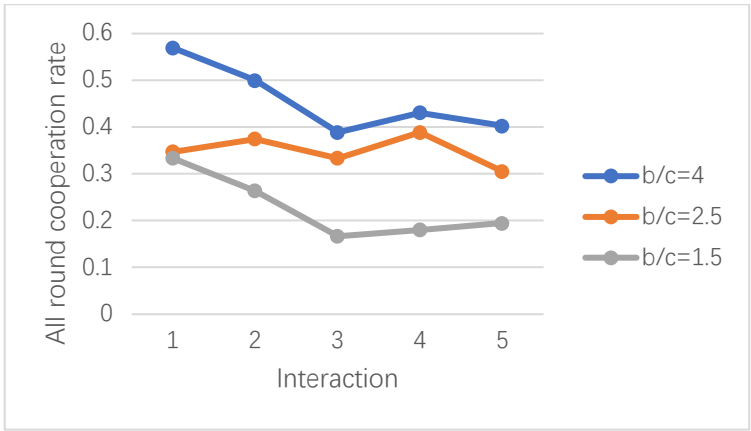

Figure -5- the relation of Cooperation Rate and Interaction based on 3 treatments

Question 2: Are total payoffs in RPDG related to individual characteristics?

Here is Table -6- shows the average payoff conducted by RPDG, and the total payoffs if game players always cooperate (ALLC payoff) with each other. In Tobit regression analysis, the frequency of cooperation in b/c=4 has a significantly negative correlation with average payoff (slope=-0.604, t=-1.25 p=0.072) and unprovoked defection increases in the first session, it means people 'learn' to defect (See Table -8-); the frequency of cooperation in b/c=2.5 have significantly negative correlation (slope=-0.022, t=-4.49, p=0.002) and unprovoked defection increases more than first session in b/c=4 (See Table -9-), it means that people learn to 'defect'; the frequency of cooperation in b/c=1.5 have significantly negative correlation (slope:-0.032, t=-3.36, p=0.008) and unprovoked defection increases again, it means that people continue 'learn' to defect. In b/c=4 and b/c=2.5 treatments, some game players chose defection at first and then others chose defection for loss aversion. In regression analysis, risk attitude has a significant positive correlation (slope=3.53, t=2.27, p=0.026) with payoffs in all rounds, and it is significantly positive with the first-round payoffs (slope=2.41, t=2.33, p=0.023) in RPDG. The education level shows a significantly positive relation to total payoffs (slope=5.53, t=1.77, p=0.081), which means that if participants' level

of education is higher, the higher total payoffs they will get. The returns to cooperation varied in RPDG, and the total payoff was positively related to risk attitude at a modest level in RPDG, otherwise, nothing is significant.

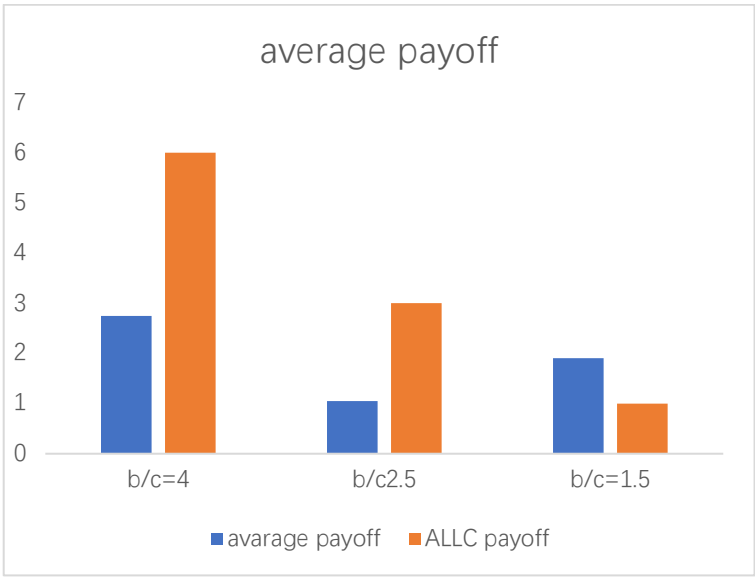

Table -6- average payoff and always cooperate payoff

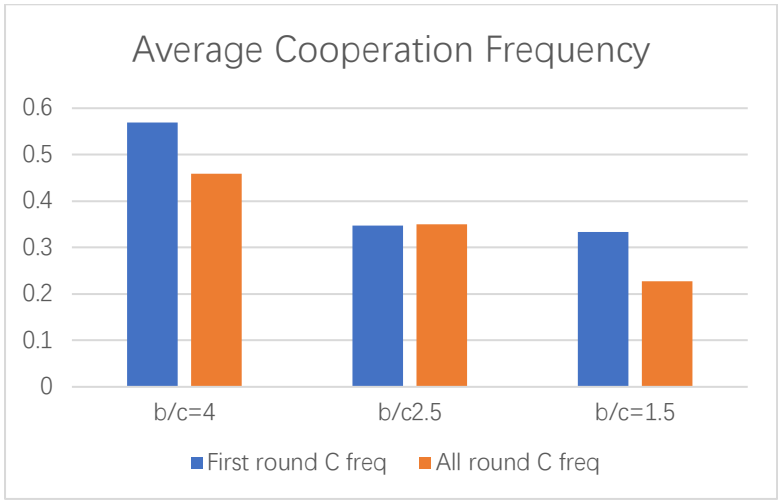

Table -7- Cooperation Frequency

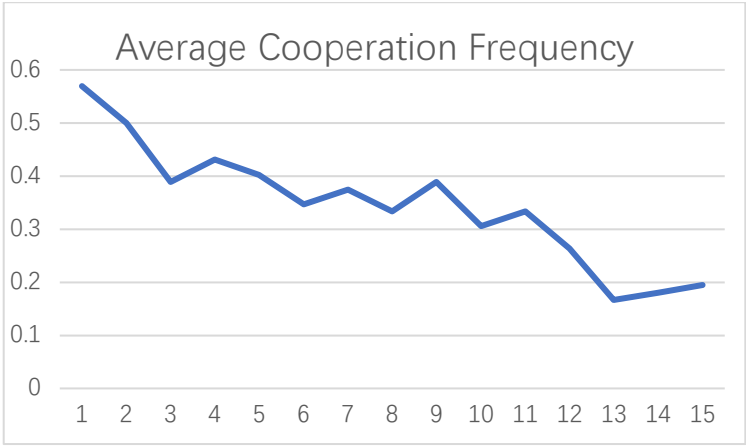

Table -8- Average Cooperation Frequency in all rounds

	Total payoffs
Gender (Female)	-5.7097 (-1.00)
Major (Econ)	-3.0082 (-0.28)
Age	-0.5128 (-0.54)
Risk attitudes	3.5344** (2.27)
Education	8.3226* (1.77)
Constant	5.5298 (0.24)
Observations	72
Robust standard errors in parentheses ***p<0.01, **p<0.05, *p<0.1	

Table -9- Total payoffs and individual characteristics

Question 3: What is the most important motivation for the cooperation?

In the motivation questionnaire, the motivations of game players to choose cooperation were examined under four different states (excluding those game players who choose 0% to cooperation), such as the reason of last round partner played Action1 (Cooperate) and you play Action 1(Cooperate), the reason of last round partner played Action1 (Cooperate) and you play Action 2 (Defection), the reason of last round partner played Action2 (Defection) and you play Action 1(Cooperate) and the reason of last round partner played Action2 (Defection) and you play Action 2 (Defection). There are four extents in total (e.g., Dreber 2014), which alternative (i) earning the most points in the long run, (ii) you wanted to help the other person earn more points (iii) It felt like the moral right thing to do (iv) you felt like it would make the other person upset if you didn't do like this.

According to the results, (i) is the strongest motivation among these four motivations among all treatments (CC, CD, DC, DD); under b/c=4 circumstance, 59%, 56%, and 62% rated (i) to (ii), (i) to (iii), and (i) to (iv) separately, under b/c=2.5 circumstance 62%, 58%, and 64% rated (i) higher than (ii), (i) higher than (iii), and (i) higher than (iv) separately, 58%, 57% and 61% rated (i) higher than (ii), (i) higher than (iii), and (i) higher than (iv) separately, under b/c=1.5 circumstance, 62%, 61% and 63% rated (i) higher than (ii), (i) higher than (iii), (i) higher than (iv) separately. Therefore, earning the most points, in the long run, is the most powerful motivation for playing cooperation strategy game players.

There are four composite measures used in this paper—the sum of (i) across all four states, the sum of (ii), the sum of (iii), and the sum of (iv)—to examine how each motivator predicts cooperation in the RPDG (e.g., Dreber 2014). I regress overall cooperation and first-round cooperation against all these composite cooperation motivations (see Table -10-), for the three treatments (b/c=4, b/c=2.5, b/c=1.5). As I mentioned before, b/c=4 and b/c=2.5 are cooperative treatments and b/c=1.5 is non-cooperative treatment.

Motivation (i) “earning the most points in the long run” is significantly positively related to all-round cooperation (p=0.026) in cooperative treatment, and first-round cooperation (p=0.091). I found the non-cooperative treatment in RPDG (b/c=1.5), motivation (i) is non-significant related to all-round cooperation (p=0.249) and first-round cooperation (p=0.404).

The motivation (ii) “you wanted to help the other person earn more points” in RPDG is significantly positively related to cooperative treatment in all-round cooperation (p=0.034) and first-round cooperation (p=0.006). In non-cooperative treatment is also significantly related to all-round cooperation (p=0.00) and first-round cooperation (p=0.006). In the non-cooperative treatment in RPDG (b/c=1.5), motivation (ii) is significantly positively related to all-round cooperation (p=0.000) and first-round cooperation (p=0.001).

The motivation (iii) “It felt like the morally right thing to do” in RPDG is a non-significant correlation in all-round cooperation (p=0.143) and first-round cooperation (p=0.131). In non-cooperative treatment in RPDG is a non-significant correlation in all-round cooperation (p=0.497) and in first-round cooperation (p=0.927).

The motivation (iv) “you felt like it would make the other person upset if you didn’t do like this” in RPDG shows non-significantly related to cooperative treatment in all-round cooperation (p=0.666) and first-round cooperation (0.529). It shows non-significant related to all-round cooperation (p=0.816) and first-round cooperation (p=0.428) in non-cooperative treatment,

In conclusion, this self-report survey adds the complement analysis of monetary payoff maximization and helps other people earn more points the most important motivation of cooperation is the desire to earn the most money across all-round and first-round repeated games.

round / treatment	all round cooperation		first round cooperation	
	cooperative treatment	non-cooperative treatment	cooperative treatment	non-cooperative treatment
(i)	0.168**	-0.032	0.028**	-0.007
(ii)	0.216**	0.168***	0.062***	0.0433***
(iii)	-0.131	-0.023	-0.0302	-0.001
(iv)	0.037	-0.007	0.012	0.0087
Constant	0.187	0.236	0.032	-0.077
Observations	72			
Robust standard errors in parentheses ***p<0.01, **p<0.05, *p<0.1				

Table -10- Motivations and Cooperation in RPDG

4.2 Conclusion

To gain insight into what kinds of people choose cooperation, I had the same subjects play a repeated prisoner's dilemma game computed payoffs of commonly used strategies and related their play to their responses to a questionnaire on attitudes, motivations, and individual characteristics. To learn more about why some people cooperated "too much" in the non-cooperative treatment and "too little" in the cooperative treatment, future research could ask players what they think about how other people's plans and goals are distributed. Such beliefs data would tell us directly which methods people thought would give them the most money and what ideas about the preferences of others were driving their calculations of what was best for themselves.

In sum, based on these results, risk aversion boosts rather than inhibits defection in cooperation-unfriendly environments. Intuitively, risk-loving may boost rather than inhibit cooperation in cooperation-unfriendly environments. Moreover, people show strong loss aversion in repeated games, if there have a possibility to lose money, people will not choose cooperation and prefer defection, and the frequency of defection will be increased by rounds. For people who have a higher

education level, they will get more payoff in an infinitely repeated game. Throughout the self-report analysis, the desire of earning the most money and helping other people to earn points is the most powerful motivation to choose cooperation in RPDG. In the cooperative treatments and non-cooperative treatments, subjects who cooperate seem to be primarily motivated by their own money earnings, and even those who do depart from payoff maximization by not cooperating do so for reasons uncorrelated with our social preference proxies. Furthermore, selfishness promotes rather than inhibits cooperation, whether risk-lover is selfish people or not remains an open question.

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국문 초록

본 논문은 무한반복형자 딜레마 게임에서 어떤 유형의 사람들이 협력 전략을 선택하는지, 특히 개인적 특성, 협력 및 총 이득 간의 관계를 분석하여 무한반복형자 딜레마 게임에서 협력의 동기를 파악하고자 합니다. 이론적 최상의 반응과 현실적 결과에 대한 내쉬 균형 측면에서 이 게임의 비교한다.

키워드: 반복 게임, 게임 이론, 죄수 딜레마, 리스크 태도, 죄수 딜레마, 개인 특성, 리스크 선호, 경제학, 성별, 교육수준

학생 번호: 2019-29997

Appendix 0 –
Definitions of Variables Used in Regression Analysis

Variable	Definition
Gender	=1 female, =0 male
Age	above 18 years old
Major	=1 Econ major, =0 otherwise
Education	=1 high school and below, =2 bachelor's degree, =3 master's degree and above
Risk attitude	=0 to 5 risk aversion, =6 to 10 risk loving
DC10 (the sum of all round cooperation in b/c=4)	=1 cooperate, =0 defect
DC20 (the sum of all round cooperation in b/c=2.5)	=1 cooperate, =0 defect
DC30 (the sum of all round cooperation in b/c=1.5)	=1 cooperate, =0 defect
Total payoff	The points earn from games
DC11 (the sum of first round cooperation in b/c=4)	=1 cooperate, =0 defect
DC21 (the sum of first round cooperation in b/c=2.5)	=1 cooperate, =0 defect
DC31 (the sum of first round cooperation in b/c=1.5)	=1 cooperate, =0 defect
PF10 (the total payoff of b/c=4)	The points earn from games
PF20 (the total payoff of b/c=2.5)	The points earn from games
PF30 (the total payoff of b/c=1.5)	The points earn from games
PF11 (the first-round payoff of b/c=4)	The points earn from games
PF21 (the first-round payoff of b/c=2.5)	The points earn from games
PF31 (the first-round payoff of b/c=1.5)	The points earn from games