ESSAYS IN EXPERIMENTAL STUDIES ON POSITIVE RECIPROCITY AND AUCTION DESIGN FOR AN OBJECT WITH COUNTERVAILING POSITIVE EXTERNALITIES

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การศึกษาพฤติกรรมการตัดสินใจในการร่วมมือกันเชิงบวก และการศึกษาการออกแบบการประมูล
สินค้าที่มีผลกระทบภายนอกเชิงบวกแบบชดเชย

นายกรภพ ภิรมย์ภักดี

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาเศรษฐศาสตรดุษฎีบัณฑิต
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Thesis Title	ESSAYS IN EXPERIMENTAL STUDIES ON POSITIVE RECIPROCITY AND AUCTION DESIGN FOR AN OBJECT WITH COUNTERVAILING POSITIVE EXTERNALITIES
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กรภพ ภิรมย์ภักดี : การศึกษาพฤติกรรมการตัดสินใจในการร่วมมือกันเชิงบวก และการศึกษาการออกแบบการประมูลสินค้าที่มีผลกระทบภายนอกเชิงบวกแบบชดเชย. (ESSAYS IN EXPERIMENTAL STUDIES ON POSITIVE RECIPROCITY AND AUCTION DESIGN FOR AN OBJECT WITH COUNTERVAILINGPOSITIVE EXTERNALITIES) อ.ที่ปรึกษาวิทยานิพนธ์หลัก : ผศ.ดร.ธนะพงษ์โพธิปิติ, 127หน้า.

วิทยานิพนธ์เล่มนี้ประกอบด้วยการศึกษาสองส่วนคือ การศึกษาพฤติกรรมการตัดสินใจ และการศึกษาการออกแบบการประมูล ในการศึกษาพฤติกรรมการตัดสินใจนั้นได้ดำเนินการในช่วงเดือน สิงหาคม-กันยายน พ.ศ. 2554 ที่คณะเศรษฐศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย โดยใช้การศึกษาแบบการทดลองทางเศรษฐศาสตร์ ซึ่งมีนิสิตระดับปริญญาตรีร่วมโดยสมัครใจจำนวน 79 คน การศึกษาได้ผลการศึกษาที่สำคัญสองหัวข้อคือ ความสัมพันธ์ระหว่างผลของต้นทุนของการให้กับการตอบแทนเชิงบวก และความสามารถในการทำนายการตัดสินใจตอบแทนของแบบจำลองที่เสนอโดย Dufwenberg and Kirchsteiger (2004) (โดยย่อเรียก DK model) การศึกษาทั้งสองหัวข้อได้ศึกษาพฤติกรรมการตอบแทนเชิงบวก

ในผลการศึกษาหัวข้อแรก ได้นำเสนอความสัมพันธ์ในเชิงทฤษฎีของปัจจัย ต้นทุนการให้ การรับรู้เจตนา และการร่วมมือเชิงบวก จากการวิเคราะห์พบว่าทั้งสามปัจจัยมีความสัมพันธ์กันเชิงบวก การศึกษายังได้นำเสนอผลวิเคราะห์จากการทดลองซึ่งทดสอบความสัมพันธ์ระหว่างต้นทุนการให้กับการตอบแทน และพบว่าทั้งสองปัจจัยมีความสัมพันธ์กันแบบเชิงบวก

ในผลการศึกษาหัวข้อที่สอง ได้ออกแบบวิธีการวัดความสามารถในการทำนายการตัดสินใจของแบบจำลองแบบที่แตกต่างจากงานวิจัยก่อนหน้านี้ และผลลัพธ์จากการทดลองแสดงให้เห็นว่า DK model มีความสามารถในการทำนายการตัดสินใจที่ดี นอกจากนี้ การศึกษายังได้เปรียบเทียบความสามารถของ DK model กับแบบจำลองทางเลือกอื่นที่ใช้ในการทำนาย คือ DG method และ Personal-info method ผลการวิเคราะห์แสดงให้เห็นว่า DK model มีความสามารถในการทำนายดีที่สุด

ในการศึกษาการออกแบบแบบการประมูล การศึกษาได้ทำการวิเคราะห์ทางทฤษฎีเพื่อเสนอการประมูลที่ดีที่สุดเมื่อใช้กับสินค้าที่มีผลกระทบภายนอกเชิงบวกแบบชดเชย การศึกษาได้เสนอการประมูลแบบใหม่ที่เรียกว่า "การประมูลแบบรับไปหรือให้มา" จากการวิเคราะห์พบว่า การประมูลดังกล่าวแก้ปัญหา Free rider และมีประสิทธิภาพในการจัดสรรทรัพยากรดีที่สุด นอกจากนี้ การศึกษายังได้ขยายผลการศึกษาด้วยการเพิ่มกฎการประมูลเข้าไปเพื่อให้ได้รายได้คาดหวังสูงขึ้น จากการวิเคราะห์พบว่าการใช้ การประมูลแบบรับไปหรือให้มาร่วมกับกฎการประมูลเพิ่มเติมที่ประกอบด้วย กฎการจ่ายค่าเข้าร่วมประมูล กฎการยกเลิกการประมูล และกฎการรวมกัน จะทำให้ได้การประมูลที่ได้รายได้คาดหวังสูงที่สุด

สาขาวิชา เศรษฐศาสตร์ ลายมือชื่อนิสิต ....

ปีการศึกษา 2556 ลายมือชื่อ อ.ที่ปรึกษาวิทยานิพนธ์หลัก ....

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KEYWORDS: RECIPROCITY / EXPERIMENT / AUCTION / EXTERNALITIES

KORNPOBBHIROMBHAKDI: ESSAYS IN EXPERIMENTAL STUDIES ON POSITIVE RECIPROCITY AND AUCTION DESIGN FOR AN OBJECT WITH COUNTERVAILINGPOSITIVE EXTERNALITIES.
ADVISOR: ASST.PROF.TANAPONG POTIPITI, Ph.D.,127 pp.

This dissertation consists of two parts: experimental study and auction design. This experimental study was conducted during August-September 2011 at the Faculty of Economics, Chulalongkorn University, Bangkok, Thailand. It set an economic experiment which consisted of four sessions and was voluntarily participated by seventy-nine undergraduate students. There are two main studies from the experiment: the relationship between perceived intention and positive reciprocity and prediction performance of a reciprocity model proposed by Dufwenberg and Kirchsteiger (2004), or "DK model." Both results are related to the positive-reciprocity behavior -- where a receiver who was given kindness by a giver kindly returns.

In the first study, it presents theoretical relationship between cost of giving and positive reciprocity. The analysis shows positive relationships between cost of giving and reciprocity. Then, it presents experimental results which tested the relationship. The results confirm this relationship.

In the second study, we test the DK model’s performance in predicting positive-reciprocity decisions. A new approach to measure the model's performance was introduced. The results show that the DK model has good performance. Furthermore, we compare the DK model's performance with two alternative prediction methods: DG method and Personal-info method. The results also show that the DK model still performed the best among them.

For the auction design, we theoretically propose auctions which are optimal to be applied to an object with countervailing-positive externalities. The newly proposed auction is called "take-or-give auction with second-price payment." Unlike the basic auction which lets bidders compete for obtaining the object, the proposed auction lets bidders compete for their desired allocation. It solves the free-rider problem and allocates the object efficiently.

Moreover, to increase the expected revenue the study proposes some extended versions of the take-or-give auction. By introducing a set of revenue-enhancing rules which include entry fee, no sale condition and pooling rule, the auction optimally maximizes the revenue. It is the revenue-maximizing auction for an object with countervailing-positive externalities.

Field of Study : Economics Student’s Signature

Academic Year : 2013 Advisor’s Signature

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CHAPTER I
INTRODUCTION

This dissertation consists of three essays organized into two parts: experimental study (Part One, Chapters II-IV)and auction design (Part Two, Chapters V-VII). This chapter briefly summarizes each essay. In the first essay, summarized in section 1.1., we aim to find the relationship between the cost of giving, intention and positive reciprocity. The second essay, which aims to measure the prediction performance of a model, is summarized in section 1.2. Last, in section 1.3., we summarize the third essay which aims to propose good auctions for an object with countervailing-positive externalities.

1.1. Cost of Giving, Intention and Positive Reciprocity

This essay (in Chapter III) investigates the relationship between cost of giving, intention and positive reciprocity. In the study, there are two parts: the first explores the theoretical relationships among the factors – cost of giving, intention and positive reciprocity – and, the second experimentally tests the theory. Theoretically, the study asserts that in a positive-reciprocity situation where a receiver returns a giver favors, the cost of giving signals the giver's intention which makes the receiver more likely to positively reciprocate. Experimentally, the study analyzes data at the *individual level*. The results support the theory.

To be more precise, *positive reciprocity* is the behavior whereby a receiver returns a giver favors. For instance, when friends give us gifts, we return them gifts. *Cost of giving* directly refers the cost for the giver to give the receiver favors. For example, in the gift-giving situation the cost of giving is the cost of the gift. Last, *intention* refers to the purposes of an agent's actions. For example, the giver gives a gift since he wants to make the receiver happy, or he gives the gift since he wants something in return.

Intention of the giver is one determinant of reciprocity which has more recently been studied. Recent studies (e.g. McCabe, Rigdon and Smith (2003)) support a positive relationship between intention and positive reciprocity. In addition, other determinants include preferences, material benefits, fairness, expectations, competitiveness, agents' relationship and information.

However, since previous literature has not specified how the receiver perceives the giver's intention, this study aims to fill this gap. More precisely, this study theoretically asserts that the cost of giving signals the giver's intention.

Following this, this study applies the theoretical results to design an experiment to test the theory. This study analyzes data at the *individual level* in contrast to previous studies that have analyzed data at the *aggregate level*. The results of the experiment support the theory. Specifically, the study finds that a receiver who reciprocates when the cost of giving is low will also reciprocate when the cost is high. In addition, a receiver is more likely to reciprocate when the cost of giving is high.

Moreover, the results shed light into insights and implications. For instance, the results explain why we perceive good intention much better on the part of friends with expensive gifts than ones with cheap gifts; therefore, we are more likely to return gifts to friends who gave us expensive gifts than to those who gave cheap ones.

1.2. Prediction Performance of DK Model

This study (in Chapter IV) experimentally tests the *prediction performance* of *DK model* proposed by Dufwenberg and Kirchsteiger (2004). The study designs an experiment that collects data which can test the model's performance at the *individual level*. Further to this, the DK model's performance is compared with other prediction methods. Results have shown the DK model to have good performance. This study also contributes to the development of design method and measurements at the individual level of the prediction performance of a model. To the best of the author's knowledge, within the field of economics, this study is the first to have applied the method. Also, some interesting observations are drawn and contribute to the existing body of knowledge.

The DK model is a famous *reciprocity model* validated for its explanatory power by many studies (e.g. Falk and Fischbacher (2006) which proposed a reciprocity model extended from the DK model). However, there have been not many studies that explore the prediction performance of the model. Hence, this study fills this gap.

The DK model was selected for testing its prediction performance since, as already mentioned, many studies have supported the model's validity of explaining reciprocity. Moreover, it is simple for application to predictive purposes. Also, the model is a belief-endogenous model which beliefs of agent determine decisions; recent studies have supported the theory that in reciprocity-related decisions beliefs play an important role (e.g. Dufwenberg and Gneezy (2000)).

1.3. Auction Design for an Object with Countervailing-Positive Externalities

This essay theoretically analyzes the equilibrium strategies of *four* auctions when they are applied to the case of an object with *countervailing-positive externalities*, which is one type of positive externality. Mainly, the analysis shows how each auction performs in allocating the object and in generating expected revenue. The auctions which are analyzed are: *second-price sealed-bid auction*(in Chapter VI) and three newly proposed auctions: *take-or-give auction with second-price payment* (in Chapter VI), *take-or-give auction with entry fee* and *take-give-indifference auction with entry fee* (both entry-fee auctions are presented in Chapter VII).

For the *second-price sealed-bid auction*, the analysis shows that due to the positive-externalities property of the object, some bidders intend to *minimize* their chances of obtaining the object by *not participating* in the auction or *participating with zero bid*. This implies that the auction does *not* provide proper incentives to these bidders. As a consequence, the auction *fails* to allocate the object efficiently or to generate high revenue.

Therefore, this study proposes a new auction – the *take-or-give auction with second-price payment* – to solve the problem of the sealed-bid auction. Analysis reveals that this new auction can successfully fix the said issue. This auction makes *efficient allocation* and generates higher revenue than sealed-bid auction.

Since, normally, we know that an efficient auction is not a revenue-maximizing auction, the study extends the take-or-give auction to yield higher revenue by adding revenue-enhancing rules (e.g. entry fee). Analysis shows that the revenue is increased when revenue-enhancing rules are added, but that efficiency of allocation is decreased. Analysis also shows that the *take-give-indifference auction with entry fee* is a *revenue-maximizing* auction for an object with countervailing-positive externalities.

CHAPTER II
REVIEWS ON ECONOMIC EXPERIMENTS AND RECIPROCITY

Suppose we hypothesize that a female receiver is given more favors than a male receiver. Without gathering data from real life, we can abstractly design a situation from which can gather data by recruiting subjects and asking them how many favors they will give when their receivers are male and female. Hence, we can carry out an analysis to test the hypothesis. Thus, this design is an "*economic experiment.*"

Like in scientific experiments, to test hypotheses the economic experiment generates data by manipulating reality; another method by which to study economics. While theoretical and empirical studies (which are more traditional methods of economic study) are on opposite extremities, the experiment is in between – being an observational study as empirical study and being an abstract study as theoretical study. In the main, as discussed in Samuelson (2004), the experiment study works together with theoretical study. Economists can apply experiments to test theories as well as to provide some insights and further develop theories.

Samuelson (2004) provided a meaningful discussion on the strengths and weaknesses of economic experiments and the linkage between theoretical and experimental studies to reality. Therefore, a brief summary is provided as follows. Since economists study how in the real world rational agents make decisions, make interactions, and make use of scarce resources, to do so, they simplify the reality to a model. In an empirical study, economists model how variables interact to each other by constructing, for instance, a regression model. A theoretical study formulates how the agents rationalize their behaviors such as their preferences, their utility functions, their possible decision spaces, and so forth. It also applies models. In the experiment study, the experimental setting is also a model – it simplifies reality. Hence, in economics all study methods apply models.

However, we may put the empirical study on the side of being closest to the real world. By having more assumptions in a model, the model is simpler but further from the real world. Hence, a theoretical study which applies *only* mathematical models (and with lots of assumptions) is to be placed on the other side – furthest from the real world. The experimental study is somewhere in between since it does not apply only mathematical models but also applies, for instance, real humans, real interactions, and manipulated situations. Hence, it studies economics with fewer assumptions than theoretical study but still with more assumptions than empirical study. However, all study methods are not separable; they must work together and contribute in sum to the knowledge of the real world.

The history of economic experiment may have begun long ago; however, it has largely gone unrecorded.[1] Formally, Thurstone (1931) is considered as the great pioneer of the economic experiment. In his work, subjects were asked to make *hypothetical* choices on their preferences. However, since it applied a hypothetical-choice method, the study was critically argued for its lack of validity. In Wallis and Friedman (1942), the main line of argument was, "for a satisfactory experiment it is essential that the subject give actual reactions to actual stimuli." According to this line of thought, the study mainly failed to manipulate reality and failed to provide proper incentives to induce subjects' real behavior. (Later, Smith (1976) proposed *induced-value theory* to improve the specifications of the incentive system in an experiment).

Kagel and Roth (1995) provided a good survey of economic experiments during the period of 1930-1995. In that period, experiments were mainly applied to test economic theories related to the prisoners' dilemma game, public goods, reciprocity (or cooperative behavior), bargaining behavior, market design, auction design and individual choice behavior. Many interesting implications from experiments were discovered. For instance, in studying reciprocity, like that found by Dresher and Flood (1950), it was found that subjects reciprocated significantly and challenged the traditional self-interested model that predicts no such reciprocity.

After about a century the economic experiment had proven its worth in studying economics. In 2002, Nobel Prize laureate Vernon L. Smith was specifically awarded "for having established laboratory experiments as a tool in empirical economic analysis, especially in the study of alternative market mechanisms." In addition there were other laureates who had applied experiments as tools in their study. For instance, in 2012, Alvin E. Roth was awarded the Nobel Prize "for the theory of stable allocations and the practice of market design."

Nowadays, the economic experiment has become widely accepted, having provided many important insights and implications. One such instance is that many experiments have provided evidence that the economic agent is not self-interested as traditional economics had believed. Since then, economists have tried to propose new models through the application of evidence from experiments (e.g. Fehr and Schmidt (1999)). Indeed, it has since been applied to a diversity of fields in economics: behavioral economics (e.g. Bhirombhakdi and Potipiti (2012B)), auctions (e.g. Kagel, Harstad and Levin (1987)), market design (e.g. Kagel and Roth (2000)),neuroeconomics (e.g. Koenigs and Tranel (2007)), and so on.

The following section focuses on related issues to the studies (Chapters III and IV) in this dissertation – experiments on reciprocity. First, it discusses how to design a good experiment. Then, it reviews the related issues of reciprocity.

[1] In fact, there is evidence which Daniel and Nicholas Bernoulli applied to the economic experiment in their study. However, this was done informally.

2.1. Designing a Good Experiment

In the words of Wallis and Friedman (1942), "for a satisfactory experiment it is essential that the subject give actual reactions to actual stimuli." Many years have passed and economists have learnt to design a good experiment through trial and error. A discussion on how to design a good experiment follows in this section which lists the issues a researcher should address when designing an experiment, namely realism, environment, incentive, duration, repetition, understanding, instruction and conductor.[2]

1. *Realism.* This means that treatments must affect behaviors like in reality. In other words, subjects should believe that the treatments are situations which have really happened in their lives. As concerns the contexts of realism, there are two types of experiment: *lab* and *field*. An experiment may be designed as a lab experiment which is less realistic as data is collected in a closed environment – that is, in an experiment room. For instance, subjects gather in a lecture room where they provide data. In contrast, the field experiment allows subjects to be exposed to other factors in an open environment – outside a room – such as place, time, weather, etc. Obviously, a field experiment is more realistic but less controllable and more likely to be confounded.

2. *Environment*. Especially in a lab experiment, the aspects of environment which subjects are exposed to affects behaviors. For instance, telling subjects that they are playing against their classmates and telling them that they are playing against an unknown individual induce different responses. The following mostly concerns the environment:

a. *Anonymity* – This refers to the experiment keeping secret the identity of each subject. This environment makes subjects neutral and independent of their opponents. Even though most experiments satisfy this aspect of environment, some experiments specifically aiming to explore the effects of identity are more relaxed about it.

b. *Privacy* – This means that subjects make decisions privately; to prevent possible effects of exogenous factors while making the decisions (e.g., facial expressions from adjacent subjects, anxiety, fear). Normally, like at voting table, screens or partitions are applied.

3. *Incentive.* Smith (1976) elaborated in detail on this issue. To make subjects truthfully express their behaviors, they must be induced by appropriate incentives. For instance, using an *Apple Store Gift Card* (for purchasing items on the online Apple Store) is appropriate only if subjects have iDevices such as iPhone or iPad. Hence, normally, money is used as the medium of rewards.

The level of payment is also another important concern. Suppose our subjects are CEOs from private companies but the payment is equal to that of a part-time officer, this may not induce true behaviors. The appropriate level of payment needs to be set equal to the subjects' opportunity costs. Since we assume that each subject can work for income instead of participating in an experiment, the opportunity cost is in the main equal to the income. For

[2] Friedman and Sunder (1994) elaborated on how to design a good experiment.

instance, in 2011 a Thai law specified a minimum 20 baht/hour salary so, at the very least, each subject should get a (expected) payment from an experiment equal to that rate.[3]

Moreover, arising from payment concerns, most researchers select subjects with low opportunity costs but who still represent the population to some degree. University students are subjects in most studies as they have low opportunity costs but enough potential to represent the population.

4. *Duration.* An experiment that is too long is not good. Subjects are prone to becoming exhausted and losing interest. Also, a lengthy experiment costs more than a shorter one. However, an experimenter should not place time constraints while subjects are making decisions, since doing so may affect behaviors.

5. *Repetition.* Collecting data from similar treatments (e.g. applying five trust games) will generate a low quality of data from *chronic nuisance* (Friedman and Sunder, 1947, pp. 29-30). The following factors cause chronic nuisance:

a. *Learning Effect* – while making decisions in similar treatments, subjects may learn or gather more information which affects behaviors.

b. *Randomization* – subjects are random in their decisions. A lengthy experiment is the potential cause.

c. *Dependent Decision* – subjects make decisions dependently across treatments. The cause of this behavior is that, rather than considering each treatment as one situation, subjects consider all treatments together as one dynamic situation and try to make decisions which maximize their expected rewards.

6. *Understanding*. With different levels of understanding of the situations they face abstractly, subjects have different responses. Unless the study wants to introduce the level of understanding as an independent variable, subjects should fully understand the situation. The level of understanding includes knowing how payoffs are calculated.

Applying less sophisticated situations (e.g. a dictator game as one player makes a decision or a trust game as two players make decisions), situations which subjects have experienced recently and providing clear instructions including examples and practice sessions can help subjects to understand the situations. Having some assistants while experimenting to answer questions is possible but be aware that the answers may confound the experiment. The assistants should be trained and monitored.

7. *Instructions*. Experiment instructions should be clear and convey the necessary information for the experiment. Also, this is the tool which helps subjects understand the situation in the experiment, and hence attempts to explain everything including payoff calculation, rules, regulations and conduct. The real purpose of the experiment can be concealed to avoid being confounded by the *experimenter demand effects* (Zizzo, 2010). However, the researcher shouldn't lie and should be aware of the results potentially being confounded by the instructions.

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[3] In 2011, Thai law specified a 215 baht/day salary at a minimum rate for the Bangkok area. Hence, assuming that 1 day is equal to 12 working hours, this equates to around 20 baht/hour at the minimum rate.

		Prisoner B	
		Defect (D)	Confess (C)
Prisoner A	Defect (D)	3,3	5,2
	Confess (C)	2,5	4,4

Figure 2.2-1 Prisoner's Dilemma Game

Instructions are given as reading papers. Therefore, subjects can read at their own convenience. However, the text should not be too long. Also, to make sure that every subject receives symmetric information provided in the instructions, in the experiment the instructions should be read to all subjects at the same time once.

8. *Conductor*. The experiment conductor – who mostly read the instructions and conduct the experiment session from start to the end – can be different persons for each session. At one extreme, the study may randomly select one subject to be the conductor for each session. This is good when concerning the design of a double-blinded experiment. However, each session can be confounded by the different characteristics of the conductors (e.g. reading skill, tone of voice, appearance, identity, etc.).

On the other extreme, the experimenter conducts the experiment by himself. This is good since the experimenter knows the best way of conducting the experiment. However, this can be confounded by the *experimenter demand effects.*

Using trained staff to conduct the experiment is somewhere in the middle of the above two mentioned choices. The staff should be well trained before handling the experiment. Also, the experimenter should be able to monitor the conductor to observe any possible confounds.

2.2. Review of Reciprocity

The history of reciprocity (or give-and-return behavior) studies most likely began in 1950 when Flood and Dresher ran an experiment by applying a game-theoretical approach.[4] Later, Flood (1952) – following on from the previous study – proposed the famous *prisoner's dilemma game*.

The game involves two players (as prisoners) who simultaneously make decisions and the outcome is determined by their decisions. Each prisoner makes a decision either to *confess* his crime or to *defect*. For instance, as presented in Figure 2.2-1, if both defect each prisoner gets three payoffs; if both confess each prisoner gets four payoffs; if one defects but the other confesses, the defector gets five payoffs but the confessor gets two payoffs. The game manipulates the dilemma whereby if a prisoner is a traditional self-interested type he will always defect; but if he has other concerns he may confess. To be more precise, if prisoner A is not a self-interested type but he concerns about *social welfare*, confession is the dominant decision; since (C,D) (stands for confession from prisoner A and defection from prisoner B) and (C,C) yield higher total payoffs (prisoner A's payoffs + prisoner B's payoffs) than (D,D) or (D,C). Or, if he is an *altruistic* type, with high concern for his friendly prisoner's payoffs, confession is the dominant decision. Also, *reciprocity* – since prisoner A

[4] The study was conducted at the RAND Corporation.

believes (or trusts) that his friend will confess, he confesses; or else, if he believes that his friend will defect, he defects – is another factor which has more recently proven the most controversial. Significantly, the results from Dresher and Flood (1950) showed that subjects acted as non-self-interested types.

Since then, many economists have addressed the problem of applying the traditional self-interested model to reciprocity-related situations. Some studies have experimentally found determinants of reciprocity, while others have theoretically proposed reciprocity models. Also, apart form the prisoner's dilemma game, some studies have applied other games which capture the sense of reciprocity such as the sequential prisoner's dilemma and trust games. These games were designed to test specific hypotheses and have now become well-known.

In the following section, we first discuss reciprocity games followed by determinants of reciprocity. Finally, we discuss reciprocity models.

2.2.1. Reciprocity Games

In experimental studies of reciprocity, most have applied a game-theoretical method. To be precise, a study designs an experiment which has many treatments introduced with different levels of independent variables. The treatments are presented in forms like *games* which let subjects make decisions in their roles and the decisions of all subjects determine the final outcome. For instance, the prisoner's dilemma game, as presented in Figure 2.2-1, is a game treatment whereby two subjects make decisions and their decisions determine the final outcome.

Apart from the prisoner's dilemma game, there are other well-known reciprocity games. Of them, we will go on to discuss sequential prisoner's dilemma and trust games.

Sequential Prisoner's Dilemma Game

The sequential prisoner's dilemma game, as presented in Figure 2.2-2, is a game in which two players sequentially make decisions; the first player moves first and then the second player moves after observing the first player's decision. The first player decides first whether to defect (D) or to confess (C). After observing the first player's decision, the second player decides whether to defect or to confess. There are four possible outcomes: (D,D), (D,C), (C,D) and (C,C). Each outcome determines the players' payoffs. For instance, the outcome (D,D) yields the first player and second player 3 and 3 payoffs respectively; the outcome (D,C) yields them 5 and 2 payoffs respectively; and vice versa.

To test hypotheses on reciprocity, applying a sequential game is better than applying a simultaneous game. In comparing the simultaneous version of prisoner's dilemma (Figure 2.2-1) and its sequential version (Figure 2.2-2), the main difference is that in the sequential version the second player responds according to the first player's decision, but in the

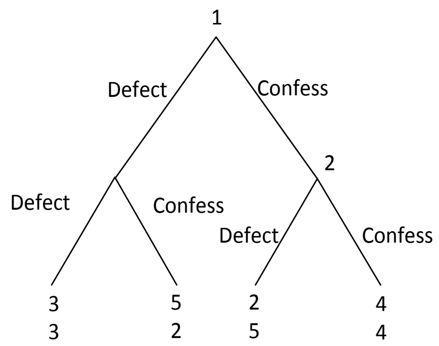

Figure 2.2-2 Sequential Prisoner's Dilemma Game

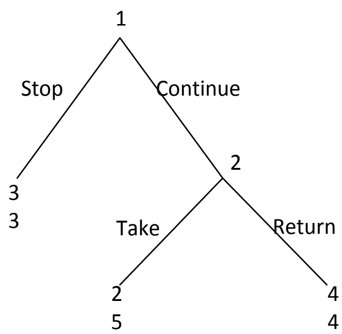

Figure 2.2-3 Trust Game

simultaneous version he decides based on his beliefs on the first player's decision. The sequential version can control the beliefs not to confound, and it can test other factors which affect reciprocity.

Trust Game

The trust game is a sequential two-player game. As presented in Figure 2.2-3, the first player decides whether to stop or to continue. If the game is stopped, each player yields 3 payoffs equally. If the game is continued, then the second player's payoffs are increased (since rather than getting 3 payoffs from stopping the game, he will get 5 or 4 payoffs depending on his decision). After observing the first player's decision, the second player decides whether to take (which yields 2 payoffs for the first player and 5 payoffs for himself) or to return (which yields 4 payoffs equally). Notice that the game can be viewed as a simpler version of the sequential prisoner's dilemma game. To be precise, continuing and returning are equivalent to confessing and taking is equivalent to defecting, while stopping is equivalent to defecting given the second player always defects.

Since the game is simpler than the sequential prisoner's dilemma, it is more convenient for introduction as a treatment in an experiment. Subjects have more understanding about the process of the game. A trust-game experiment can directly focus on reciprocal behavior (or returning in the game) and is less confounded by possible factors related to the choice set. More specifically, in the sequential prisoner's dilemma game its choice set induces four different outcomes, but in the trust game the choice set induces three outcomes.

2.2.2. Determinants of Reciprocity

Reciprocity, or give-and-return behavior, has been the subject of much focus over recent years. There are two types of reciprocity: positive and negative. *Positive reciprocity* is a situation where a person kindly does something to another person and the second person kindly reciprocates. For example, a man gives a woman a gift and she returns him a gift. On the contrary, *negative reciprocity* is a situation where a person does something bad to another person and the second person retaliates. For example, a man steps on someone's foot and the victim retaliates by punching him.

Besides challenges to the traditional theory of economics – which has no explanation regarding reciprocity – reciprocity is an interesting interaction. In most situations, positive reciprocity is a promising solution to achieve either the social or individual optimum. For instance, in international trade, an agreement between countries represents a kind of positive reciprocity. With the agreement, the overall economy is better than without it. In the case of duopoly, cooperation between firms represents a kind of positive reciprocity. The cooperative duopoly yields a higher total profit than a competitive one. The opposite – negative reciprocity – can result in huge losses to society such as the extremes of war and retaliation.

To know how reciprocity – either positive or negative – occurs, many studies have investigated the determinants of reciprocity. Some of the determinants are as follows:

- *Altruism.* "Altruism (or selflessness) is the principle or practice of concern for the welfare of others."[5] Obviously, it is on the opposite side of the traditional self-interested model in economics. The altruistic factor is the most basic determinant of reciprocity. It simply explains that an agent positively reciprocates since he cares about others' welfare. In a more sophisticated version of the altruistic model, an agent may care for both himself and others' welfare. Rotemberg (2006) investigated the relationship between altruism and reciprocity at the workplace and found there to be a significant relationship.

- *Beliefs.* Since Geankoplos et al. (1989) proposed the psychological game theory, many studies have investigated the impact of beliefs on reciprocity and supported it (Csukás et al., 2008; Falk et al., 2008; Stanca et al., 2009). For instance, in a simultaneous prisoner's dilemma each player's decision depends on his beliefs; if he believes the other will confess, he will confess; and vice versa. In a sequential game, the first player's decision depends on his beliefs regarding other decisions and induced outcome. Beliefs, as determinants to reciprocity, have been expressed differently in each study. Dufwenberg and Kirchsteiger (2004) proposed that an agent derives his equity point under his beliefs. While, for Falk and Fischbacher (2006), beliefs are expressed as intention.

5 Wikipedia, accessed 02/02/13.<www.en.wikipedia.org>

- *Competition.* In a competitive environment, an agent may want to get higher payoffs than others since he wants to *win.* Fehr and Schmidt (1999) introduced the concerns of competition in the form of advantage and disadvantage factors. To be precise, an agent prefers an advantageous choice (which yields him higher payoffs than others) to a disadvantageous one.

- *Equity*. In law, equity means "a system of natural justice allowing a fair judgment in a situation which is not covered by the existing laws."[6] Here, in reciprocity, equity has a similar meaning. That is, in a reciprocity-related situation, agents care about equity, a fair judgment and a fair decision in the situation which there is no law directly specifying which decision is a fair one.

Reciprocity, it is believed, happens because of the concern of fairness. Theoretically, in economics, some studies proposed how an agent judges fairness. For instance, Fehr and Schmidt (1999) proposed that the equal split (which means all players get the same payoffs) is the equity point. Dufwenberg and Kirchsteiger (2004) proposed that the arithmetic mean between the possible highest and lowest payoffs of each player is his equity point.

- *Loss aversion.* For instance, given the initial amount of money (let's say \$10), we let subjects make decisions in two treatments: first, each subject makes a decision on how much money to take and, second, we give a subject \$10 and let him make decision on how much he will throw away. The difference between both treatments is that in the first treatment a subject makes a "decision to gain" and in the second treatment he makes a "decision to lose." The treatments seem equivalent. However, loss aversion affects the second treatment and yields different results. Loss aversion also affects reciprocity situations, this is supported by the work of Bhirombhakdi and Potipiti (2012A).

- *Relationship*. Personal relationship is a determinant of reciprocity. It is very clear that we care about our friends' welfare more than that of strangers. Dufwenberg and Kirchsteiger (2004) discussed this factor in their proposed model.

- *Sensitivity*. Sensitivity is introduced to allow each agent to have a different response in the same situation. For instance, a highly sensitive altruist may reciprocate in any situation while one with low sensitivity reciprocates only in certain situations. Rushton et al. (1981) applied an agent's personality to measure altruistic sensitivity. Also, an agent may be concerned with more than one factor to different degrees of sensitivity. For instance, an agent may be concerned with both equity and competition (Fehr and Schmidt, 1999).

- *Uncertainty*. Since an agent may be a risk-lover, risk-averse or risk-neutral type, uncertainty affects his decision. For instance, in the trust game where stopping the game yields a certain outcome but continuing the game yields an uncertain outcome (depends on the second player's decision), a risk-averse player may prefer stopping. (For example, see Bird et al. (2002)).

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[6] Definition from Oxford Advanced Learner's Dictionary, 7 ed.

- *Utilitarianism.* According to the ethical philosopher Jeremy Bentham, "the greatest happiness of the greatest number that is the measure of right and wrong." This is the central concept of utilitarianism.[7] So, a utilitarian is mostly concerned about the total welfare of society. This differs from altruism in which an altruist is concerned for the welfare of others, not the total welfare. More precisely, a utilitarian always prefers the choice which maximizes social welfare without concern for the distribution (Komter, 2007).

2.2.3. Reciprocity Models

As mentioned, some recent studies aimed to propose new reciprocity models which fit the existing evidence. In this sub-section, we discuss the reciprocity models of Fehr and Schmidt (1999), Rabin (1993), Falk and Fischbacher (2006), Dufwenberg and Kirchsteiger (2004) and Battigalli and Dufwenberg (2007).

The model, here, means the utility function; a reciprocity model proposes how an agent derives his utility, or payoffs, in a reciprocity-related situation. The proposed models can be classified into two types: *traditional* (e.g. Fehr and Schmidt (1999)) and *psychological* (e.g. Dufwenberg and Kirchsteiger (2004) and Battigalli and Dufwenberg (2007)). The difference between both types of model is that *beliefs* (the expectations of other players' decisions) *endogenously* determine a decision in the psychological models while they do not in the traditional model (Geanakoplos, et al., 1989; Battigalli and Dufwenberg, 2009). In a traditional model, an agent derives his utility from the ex-post outcome induced by the strategy profile. In the psychological model, an agent derives his utility from both the ex-post outcome and his beliefs of the ex-post outcome while playing the game (or *interim expectation on outcome*).

Mathematically, for a player i, the traditional model maps from strategy profile Z to utility:

$$v_i: Z \to \mathbb{R}.$$

For instance, in the self-interested model the function is $v_i = m_i(z)$ where m_i is the *material payoffs* of player i and $z \in Z$. In the altruistic model the function is $\tilde{v}_i = m_i(z) + \mu_i m_j(z)$ where $\mu_i \geq 0$ is the altruistic parameter of player i. In the altruistic model, the second term is his opponent's material payoffs; it increases the player i's utility which means he cares about his opponent's welfare. However, the altruistic parameter $\mu_i \geq 0$ stands for the player's individual preferences, or sensitivity, on altruism (see section 2.2.2. for the discussion of determinants of reciprocity e.g. altruism, individual preferences, sensitivity, etc.). Similarly, Fehr and Schmidt (1999) proposed an interesting traditional-reciprocal model called the "*inequity aversion*" model. This is as follows:

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7 The quote is from his most famous work, "A Fragment on Government."

$$v_i^{IA}(z;\alpha_i,\beta_i) = \begin{cases} m_i(z)\ ;\ m_i(z) = m_j(z) \\ m_i(z) - \alpha_i\left(m_i(z) - m_j(z)\right)\ ;\ m_i(z) > m_j(z) \\ m_i(z) - \beta_i\left(m_j(z) - m_i(z)\right)\ ;\ m_i(z) < m_j(z) \end{cases}$$

where $\alpha_i \geq 0$ is the individual sensitivity parameter of *advantage* outcome ($m_i > m_j$) and $\beta_i \geq 0$ is the individual sensitivity parameters of *disadvantage* outcome ($m_i < m_j$). The model introduces two determinants: equity (which uses the equal split as equity point) and preferences. In the model, when $m_i(z) \neq m_j(z)$, the second term stands for disutility from having inequity (or, as its name captures, inequity aversion). However, the player may have different preferences in being an advantage (when $m_i > m_j$) and disadvantage (when $m_i < m_j$) by having α_i and β_i as sensitivity respectively.

Differently, the psychological model maps from the strategy profile and beliefs B_i to utility:

$$u_i: Z \times B_i \to \mathbb{R}.$$

In a psychological model, an agent derives his utility from two parts: material m_i and *psychological* payoffs; or in this context, the psychological payoff is called "*reciprocal*" payoff r_i and we call the model "*reciprocity model.*" With the additively separable assumption, a reciprocity model is expressed as $u_i = m_i(z) + r_i(z, b_i; \boldsymbol{\mu_i})$ where $b_i \in B_i$ and $\boldsymbol{\mu_i} \in \mathbb{R}^n$ is the vector of *reciprocal parameters*. Mostly, the proposed models are different in how they specify the reciprocal-payoff function.

For instance, Rabin's (1993) and Dufwenberg and Kirchsteiger's (2004) models capture the sense of kindness (or unkindness) and reciprocity. The models similarly specify their reciprocal-payoff functions as $r_i^K = \emptyset_i * kindness\ giving * kindness\ perceving$ where $\emptyset_i \geq 0$ is the only parameter which, in this context, is called "*kindness sensitivity.*" Or, as another example, Falk and Fischbacher (2006) added intention in the kindness-reciprocity model by specifying the reciprocal-payoff function as $r_i^{IK} = \emptyset_i * \delta_i * kindness\ giving * kindness\ perceving$ where $0 \leq \delta_i \leq 1$ is the *intention factor*.

CHAPTER III
COST OF GIVING, INTENTION AND POSITIVE RECIPROCITY[8]

This chapter investigates the relationship between the cost of giving, intention and positive reciprocity. The study comprises two parts: first, presenting the theoretical relationship between the factors – cost of giving, intention and positive reciprocity – and, second, experimentally testing the theory. Theoretically, the study explains that in a positive-reciprocity situation where a receiver returns a giver favors, the cost of giving signals the giver's intention which makes the receiver more likely to positively reciprocate. Experimentally, the study analyzes data at the *individual level*. The results support the theory.

Positive reciprocity is the behavior whereby a receiver returns a giver favors. It is an interesting interaction for several reasons. First, in most situations, positive reciprocity is economically important. The reciprocal (or give-and-return) outcome is better than a competitive outcome. For example, in a duopoly market, a reciprocating duopoly yields a higher total profit than a competitive duopoly. In the prisoner's dilemma, a reciprocal outcome is a Pareto optimum. Second, since much evidence has shown that, in reality, reciprocity does happen but the traditional self-interested model cannot explain reciprocity, this implies that economists should develop new models which can explain reciprocity. Altruism, utilitarianism, kindness and reciprocity and inequity aversion are all examples of the new reciprocity models.

"*How does positive reciprocity occur?*" is the important question. In economics, many studies have investigated determinants of reciprocity,[9] e.g. preferences, material benefits, fairness, expectations, competitiveness, agents' relationship, information. The focus of more recent studies – *intention of the giver* – is one such determinant (e.g. Stanca, Bruni and Corazzini (2009)). Hence, it is of interest to investigate, in more depth, intention.

Previous studies on the giver's intention and reciprocity showed that good, or altruistic, intention enhances positive reciprocity (McCabe, Rigdon and Smith, 2003; Falk, Fehr and Fischbacher, 2008; Stanca, Bruni and Corzzini, 2009). For instance, with your good intention – to celebrate, to wish them luck, to make them happy – giving your friends gifts induces return gifts from your friends. Or with good intention – to defend the country, to keep

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8 This study was published as "Cost of Action, Perceived Intention, Positive Reciprocity and Signaling Model," in the Journal of Business and Policy Research, Vol. 7, No. 3, September 2012 Special Issue, pp. 178-194.

9 For examples, Bolle (1998), Fehr and Schmidt (1999), Fehr and Gächter (2000), Bolton and Ockenfels (2000 and 2005), Charness and Rabin (2002), Falk et al. (2003 and 2008), Falk and Fischbacher (2006), McCabe et al. (2003), Brülhart and Usunier (2004), Dufwenberg and Kirchsteiger (2004), Cox and Deck (2005), Csukás et al. (2008), Stanca et al. (2009), Bhirombhakdi and Potipiti (2012A and 2012B).

the people secure in the country, to provide selfless service – military officers are rewarded with medals, support and privileges in return.

However, in an interaction like gift giving and returning, how the receiver perceives the giver's intention is still an important question which previous studies do not explain. Hence, this study fills the gap.

This study theoretically analyzes the relationship between the cost of giving, giver's altruistic intention and positive reciprocity by applying a signaling model. The theoretical result supports the assertion that the cost of giving can signal the giver's altruistic intention and enhances positive reciprocity. Furthermore, this study designs an experiment to test the theoretical relationship between the cost of giving and positive reciprocity. The results also support the relationship.

Regarding implications, the finding explains why we give expensive gifts rather than cheap ones. The givers give expensive gifts since the high cost of giving, or the high cost of the gifts, is better to signal the givers' altruistic intention than a cheap one. Also, the finding explains why we are more likely to return favors to the high-cost givers than low-cost ones.

The following in this chapter starts with a review of intention and reciprocity (section 3.1.). Then, it presents the theoretical relationships between cost of giving, intention and reciprocity (section 3.2.), presents the experimental results (section 3.3.) and, finally, draws conclusions (section 3.4.).

3.1. Review of Intention and Reciprocity

Recent studies on kindness and reciprocity have discussed one new factor – *perception of the giver's intention* – that determines how a receiver returns kindness (or unkindness) (Charness and Rabin, 2002; McCabe, Rigdon and Smith, 2003; Falk, Fehr and Fischbacher, 2003, 2008; Dufwenberg and Kirchsteiger, 2004; Bolton and Ockenfels, 2005; Cox and Deck, 2005; Falk and Fischbacher, 2006; Stanca, Bruni and Corzzini, 2009).[10] For instance, stepping on someone's foot is more likely to induce a fight (as an unkind return) if the victim perceives the doer's unkind intention (such as the doer really wants to hurt him), and vice versa for kind intention. In other words, the perception of the giver's kind intention induces the receiver's kind reciprocity; and the perception of unkind intention induces unkind reciprocity (Falk and Fischbacher, 2006).

McCabe et al. (2003), Falk et al. (2008) and Stanca et al. (2009) studied the relationship between perception of giver's intention and reciprocity. McCabe et al. (2003) and Falk et al. (2008) had a similar hypothesis whereby the reciprocity rate when a giver can fully control his decision (or intended decision) is higher than when a giver cannot fully do so (or

[10] Stanca et al. (2009) defined a new factor named *motivation,* but, in the article's model, the motivation and perception of the giver's intention are closely related. Hence, the effects of motivation and the perception can be aggregated into only the perception.

unintended decision). The studies applied random devices to manipulate the unintended decision. More precisely, making a decision by applying a random device implies that the giver has made an unintended decision.

The results supported the hypothesis of a positive relationship between the perception of giver's intention and reciprocity. However, the result is arguably confounded. In the unintended-decision treatment, the interaction of a pair comprising a giver and receiver has a third party involved. For instance, for Falk et al. (2008), instead of the real giver by himself, the experimenter was the one who applied the device; the experimenter is the third party. Also, the device, by itself, is concerned as the third party who determines the giver's decision.

Stanca et al. (2009) hypothesized that the reciprocity rate when a giver has altruistic intention is higher than when he has strategic (or non-altruistic) intention. The study designed two treatments. One let the giver show strategic intention by providing them with all the possible consequences from his action; for instance, the giver knows that if he gives the receiver favors then the receiver may return favors. In contrast, the other treatment lets the giver show altruistic intention by not providing the possible consequences of his action; for instance, the giver may give the receiver favors without knowing that the receiver may return favors. The results supported the hypothesis.

In this study, we question whether cost of giving can signal the giver's altruistic intention and can induce reciprocity. This study comprises two parts: first, presenting the theoretical relationship between the factors and, second, experimentally testing the theory. In the next section, we will address the theoretical relationship.

3.2. Theory of Cost of Giving, Intention and Positive Reciprocity

In this section, we develop a model to show the relationship between cost of giving, giver's intention and positive reciprocity. The model shows that, in a positive-reciprocity situation where a receiver returns a giver favors, the cost of giving signals the giver's intention and induces positive reciprocity.

As follows in this section, we will theoretically develop the relationship between cost of giving, giver's intention and positive reciprocity. To show this, first, we discuss the *positive-reciprocity trust game* which is used in our analysis. Second, we discuss the agent's utility model. Last, we apply the presented game and model to develop the relationship between cost of giving, giver's intention and positive reciprocity.

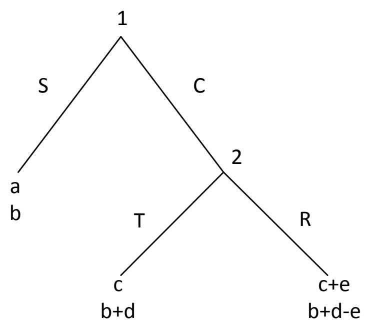

Figure 3.2-1 Positive-Reciprocity Trust Game.

3.2.1. Positive-Reciprocity Trust Game

In our analysis, we focus on the positive-reciprocity interaction. For instance, friends give us gifts and we return them gifts. This situation is captured by the *positive-reciprocity trust game* as presented in Figure 3.2.1.

In the game, the giver (as the first player) decides whether to stop (S) or trustfully continue (C) the game. If he continues, he gives the receiver (as the second player) d additional *monetary payoffs*, or money that the players get from the interaction, and his payoffs are changed from a to c. Notice that the giver continuing is similar to the gift giving wherebe the cost of giving is the difference between *a* and *c* (Definition 3.2-1):

DEFINITION 3.2-1: *Cost of giving is* $\delta = a - c$.

The receiver, after observing the continuation of the giver, decides whether to selfishly take (T) all additional payoffs (which yield him $b + d$ monetary payoffs) or reciprocally return (R) e payoffs (which yield the giver and himself $c + e$ and $b + d - e$ payoffs respectively). Notice that the receiver's reciprocity is similar to returning the giver a gift.

Note that the payoff structure (a, b, c, d, e) of the game presents the monetary payoffs, not the total payoffs, or utility, which the players derive and affect decisions. In the next section, we discuss how a giver and a receiver derive their utility.

3.2.2. Utility Function

$$u_i\left(\mathbf{z}, \widehat{\emptyset_j}; \emptyset_i\right) = m_i(\mathbf{z}) + \emptyset_i \widehat{\emptyset_j} m_j(\mathbf{z}). \qquad (3.2-1)$$

As mentioned, each agent will derive utility not equal to the monetary payoffs as specified in the game. This section will discuss how an agent derives his utility. Equation (3.2-1) presented the *modified altruistic model* which explains how an agent derives the utility.

From the equation, agent *i* derives his utility from two parts: his *monetary payoffs* (in the first term) and his *altruistic payoffs* (in the second term). His monetary payoffs m_i are determined by the strategy profile $\boldsymbol{z}$. The strategy profile $\boldsymbol{z}$ explains how the giver and the receiver make decisions. According to the positive-reciprocity trust game, as presented in Figure 3.2-1, we denote $i, j \in \{1,2\}$ and $i \neq j$ as the index of the first (as giver) and second (as receiver) players; $\boldsymbol{z} = (z_1, z_2)$ where $z_1 \in [0,1]$ is the probability of continuing the game (by the giver) and $z_2 \in [0,1]$ is the probability of taking (by the receiver). For instance, if the giver continues the game and the receiver does not reciprocate ($\boldsymbol{z} = (1,1)$), the giver gets *monetary payoffs* $m_1 = c$ and the receiver gets $m_1 = b + d$.

The altruistic parameter of agent i, $\emptyset_i \geq 0$, is an individual characteristic, or *type*. In our context, we interpret it as his altruistic intention. It is the private information of agent i, which agent j does not exactly know. Similarly, agent j has his intention $\emptyset_j$ which agent i does not know. From the agent i's perspective, he guesses agent j's intention $\widehat{\emptyset_j} \geq 0$ according to his perceptions. Similarly, agent j guesses agent i's intention $\widehat{\emptyset_i}$ according to his perceptions. Rationally, agent i guesses $\widehat{\emptyset_j}$ by forming an expectation of agent j's intention. Hence, for convenience, we call the term $\widehat{\emptyset_j}$ the expectation of agent j's intention.

Notice that having a high value of agent i's altruistic intention $\emptyset_i$ or expectation of agent j's altruistic intention $\widehat{\emptyset_j}$ implies that agent i is concerned more about the monetary payoffs of his partner, agent j, than his monetary payoffs. Also, if agent i does not have an altruistic intention toward his partner ($\emptyset_i = 0$) or perceives no altruistic intention from him ($\widehat{\emptyset_j} = 0$) then agent i will act like a self-interested agent. That is, agent i will only be concerned with his monetary payoffs.

3.3.3. The Relationship between Cost of Giving, Giver's Intention and Reciprocity

This section shows the relationship between cost of giving, giver's intention and positive reciprocity. As presented in Figure 3.2-2, the following analysis shows that: i) the cost of giving signals the giver's intention, ii) since a receiver knows the cost, he can derive the expectation of the giver's intention, iii) the expectation of the giver's intention induces reciprocity. In other words, the more the cost of giving the more likely the receiver reciprocates.

To show the relationship, we present in three sections. First, we investigate the relationship between cost of giving and giver's intention. Second, we investigate the relationship between giver's intention and expectation of giver's intention. Last, we investigate the relationship between the expectation of giver's intention and reciprocity.

Cost of giving and giver's intention

This section shows that cost of giving is the proxy of the giver's intention. Consider the previous example of gift giving, it is normal that we are more likely to return (or

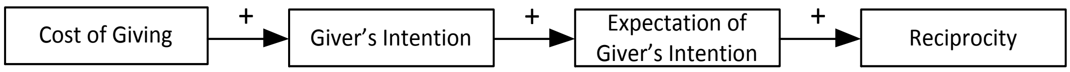

Figure 3.2-2 Positive Relationship Between Cost of Giving, Giver's Intention, Expectation of Giver's Intention and Reciprocity.

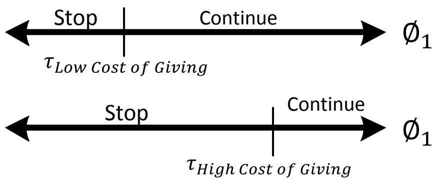

Figure 3.2-3 Relationship between Cost of Giving, Critical Value, Giver's Intention and Decision.

reciprocate) a giver who gave an expensive gift (or, in other words, who had a high cost of giving) than one who gave a cheap gift – the cost of giving and positive reciprocity have positive relationship. From the following formal analysis, we will also obtain the relationship.

Next, from the presented game (in Figure 3.2-1), we will analyze for the giver's best response function. From (3.2-1), we derive the giver (as the first player)'s utility function as presented in (3.2-2),

$$u_1\left(\boldsymbol{z}, \widehat{\emptyset_2}; \emptyset_1\right) = m_1(\boldsymbol{z}) + \emptyset_1 \widehat{\emptyset_2} m_2(\boldsymbol{z}). \qquad (3.2-2)$$

Since the giver moves first, he simply takes the expectation of the receiver (as the second player)'s intention $\widehat{\emptyset_2}$as a constant; we normalize $\widehat{\emptyset_2} = 1$. Then, we derive the giver's best response BR_1 as

$$BR_1(z_2; \emptyset_1) = \left\{ z_1 \middle| z_1 = \begin{cases} 0\ (Stop)\ if\ \emptyset_1 \leq \tau(\delta, z_2) \\ 1\ (Continue)\ if\ \emptyset_1 \geq \tau(\delta, z_2) \end{cases} \right\} \qquad (3.2-3)$$

where *critical value of intention* $\tau(\delta, z_2) = \frac{\delta - e(1-z_2)}{d - e(1-z_2)}$.

The giver's best response is contingent on his altruistic intention $\emptyset_1$ and cost of giving δ (as defined in Definition 3.2-1) which is one component in the critical value of intention τ. The relationship between cost of giving, critical value of intention, the giver's intention and his best response is presented in Figure 3.2-3. The critical value is increasing in the cost of giving. Also, if the giver's intention is higher than the critical value then he will continue the game.

Notice that the presented relationship implies a positive relationship between the cost of giving and the giver's intention. As presented in Figure 3.2-2, since the critical value is increasing in the cost of giving, the expectation of the giver's intention given his continuing decision is also increasing in the cost. In other words, we can say that the cost of giving signals the giver's intention (Proposition 3.2-1). Henceforth, we will use the cost of giving as an interchangeable term for the giver's altruistic intention.

PROPOSITION 3.2-1: *Cost of giving signals the giver's altruistic intention.*

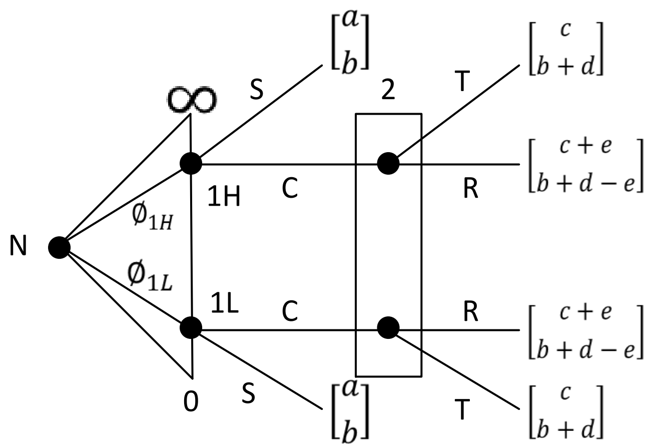

Figure 3.2-4 Signaling Game of Trust.

Cost of giving and expectation of the giver's intention

In this section, we develop the link between the cost of giving and expectation of the giver's intention. Intuitively, since the receiver knows the game structure, including knowing the cost of giving, and can access the giver's best response function as presented in (3.2-3), the receiver knows the positive relationship between the cost and the giver's intention.[11] Hence, it is rational to derive the expectation of the giver's intention that positively relates with the cost of giving. As follows in this section, we formally develop how the cost of giving positively relates with the expectation of the giver's intention (Proposition 3.2-2).

From the positive-reciprocity trust game (as presented in Figure 3.2-1), we change the game to the signaling game of trust as presented in Figure 3.2-4. The difference between the games is that in the signaling version the nature (as player N) randomly selects the altruistic intention of the giver (as player 1, 1H and 1L represent givers with high and low altruistic intention respectively) whom the receiver (as player 2) is faced with; and, since the intention is the giver's private information, the receiver cannot distinguish the giver's intention after observing his decision. Also, note that the payoff structure (a, b, c, d, e) specified in the game is *monetary payoffs*, not the *utility* through which agents derive and determine decisions.

In this signaling game, since the receiver does not know the giver's real intention, he derives an expectation of the giver's intention according to his perception. Since he knows the giver's decision, he utilizes this information as a signal to update the expectation of the giver's intention. Therefore, the expectation of the giver's intention $\widehat{\emptyset_1}$ is derived as defined in Definition 3.2-2:

DEFINITION 3.2-2: $\widehat{\emptyset_1} = E[\emptyset_1|z_1]$.[12]

---

[11] Since game theory has an intrinsic assumption that the form of each player's utility function is publicly known (but an individual parameter like type is still private information), everybody can exploit this public knowledge and access each player's best response function.

[12] Similarly, if we consider how the giver perceives the receiver's kindness intention, $\widehat{\emptyset_2} = E[\emptyset_2|z_2]$; the giver does not know z_2 hence he uses his expectation that $z_2 = \alpha$. Applying $\widehat{\emptyset_2} = E[\emptyset_2|z_2 = \alpha]$ instead of the normalization (which $\widehat{\emptyset_2} = 1$) does not affect our analysis.

Since, in the game, the receiver's decision node is reached if the giver continues the game the expectation of the giver's intention is $\widehat{\emptyset_1} = E[\emptyset_1|C]$. As discussed in Proposition 3.2-1, $E[\emptyset_1|C]$ is increasing in the cost of giving, therefore the expectation of the giver's intention $\widehat{\emptyset_1}$ and the cost of giving has a positive relationship (Proposition 3.2-2).

PROPOSITION 3.2-2: *The expectation of the giver's intention increases in the cost of giving.*

Cost of giving and reciprocity

This section develops the link between cost of giving and reciprocity. To show it, we consider the receiver whose utility function is

$$u_2(\boldsymbol{z}, \widehat{\emptyset_1}; \emptyset_2) = m_2(\boldsymbol{z}) + \emptyset_2 \widehat{\emptyset_1} m_1(\boldsymbol{z}). \qquad (3.2-4)$$

From the utility function, notice that when the expectation of the giver's intention $\widehat{\emptyset_1}$ increases, the receiver's *altruistic payoffs* (the second term) increases. As a consequence, the receiver is more likely to return the giver monetary payoffs. In other words, the expectation of the giver's intention has a positive relationship with reciprocity. Since the cost of giving positively relates with the expectation of the giver's intention, the cost of giving also positively relates with reciprocity (Proposition 3.2-3).

PROPOSITION 3.2-3: *The receiver is more likely to reciprocate when the cost of giving is increased.*

3.3. Experiment Results

This section presents the experimental results which test the relationship between cost of giving and positive reciprocity (Proposition 3.2-3).[13] To test the proposition, we derive four hypotheses: two hypotheses test the proposition at aggregate level and the other two hypotheses test it at individual level.

H1: *In treatments with equal cost of giving, reciprocity rates are equal.*
H2: *The reciprocity rate of treatment with low cost of giving (low-cost treatment) is lower than that of the treatment with high cost of giving (high-cost treatment).*

The first and second hypotheses (H1 and H2) test at aggregate level whether the receiver is more likely to reciprocate when the cost of giving is increased, as stated in Proposition 3.2-3. From the proposition, first, we expect that if receivers make decisions (to take or to reciprocate) in two treatments whereby the giver has equal cost of giving then the proportion of receivers who reciprocate, or the *reciprocity rate*, in both treatments should be equal. Second, we expect that if receivers make one decision in a treatment with a low cost of

[13] Experiment protocol is provided in Appendix A.

giving and another decision in a treatment with a high cost of giving, then the reciprocity rate in the high-cost treatment should be higher than in the low-cost one.

H3: *A subject who reciprocates in low-cost treatment will reciprocate in high-cost treatment.*
H4: *A subject who does not reciprocate in high-cost treatment will not reciprocate in low-cost treatment.*

However, since testing only H1 and H2 is not enough to support the proposition, we additionally test another two hypotheses, H3 and H4, which test the proposition at individual level. In fact, H3 and H4 are logically equivalent. However, as will be seen later in this section, the measurements to test H3 and H4 are different.

To understand why H3 and H4 are necessary to validate the relationship, consider the following illustration. Suppose we have three subjects, say Mr. A, B, and C and we have two treatments with different levels of cost of giving – high and low. In the low-cost treatment only Mr. A chooses to return (reciprocity rate is 33%) and in the high-cost one Mr. B and C choose to return (reciprocity rate in 67%). The results support H2: the reciprocity rate of low-cost treatment is lower than that of the high-cost one. However, the results do not support H3: a subject who reciprocates in low-cost treatment will reciprocate in high-cost treatment. Therefore, to validate the relationship, all four hypotheses should be supported by the results.

The following presents the results in four sections testing each hypothesis.

3.3.1. Testing H1

This section tests H1: in treatments with equal cost of giving, reciprocity rates are equal. This section first presents and discusses the treatments with equal cost of giving. Second, it statistically tests the hypothesis.

Treatments with equal cost of giving: HHT and LHT

To test H1, two treatments were designed: high-payoff high-cost treatment (HHT) and low-payoff high-cost treatment (LHT). The treatments are presented in Table 3.3-1.

According to the positive-reciprocity trust game as presented in Figure 3.2-1, the game has a *material-payoffs* structure (a, b, c, d, e). In the treatments HHT and LHT, they have $a = c$ to make them equally have zero cost of giving. In other words, continuing the game does not cost the giver; but it still gives the receiver additional material payoffs. To control other confounds, the treatments have $a = b$, $d = 300$ and $e = 100$.[14] However, it is unavoidable that the treatments are confounded by the different levels of stakes.

[14] The treatments are controlled for the effects of initial endowments (by having $a = b$), of the critical value of intention τ (see (3.2-3)), of social welfare (see Charness and Rabin (2002)), of advantage (see Fehr and Schmidt (1999)) and of loss aversion (see Bhirombhakdi and Potipiti (2012A)).

Table 3.3-1 Treatments with Equal Cost of Giving: HHT and LHT.

Name	a	b	c	d	e	Cost of giving $\delta = a - c$	Stake (classified by a)
High-payoff and high-cost treatment (HHT)	100	100	100	300	100	0	High
Low-payoff and high-cost treatment (LHT)	50	50	50	300	100	0	Low

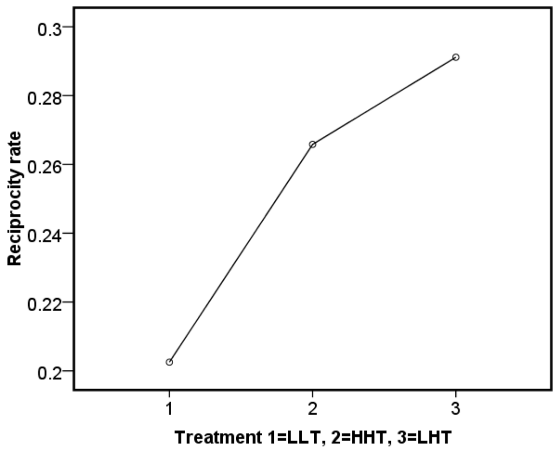

Figure 3.3-1 Reciprocity Rates of Treatments.

Result

The reciprocity rate of each treatment is presented in Figure 3.3-1. The reciprocity rates of HHT and LHT are 27% and 29% respectively. (LLT is a low-cost treatment discussed in the following section).

According to H1: in treatments with equal cost of giving reciprocity rates are equal, we expect the rate of LHT and of HHT to be equal. To statistically test the hypothesis, we apply a logistic regression model as presented in (3.3-1):

$$\ln\left(\frac{Y_{ik}}{1 - Y_{ik}}\right) = \beta_0 + \beta_1 D_{ik,2} + \varepsilon_{ij} \qquad (3.3-1)$$

where Y_{ik}= 1 if the decision of i^{th} subject in k^{th} treatment is returning R and = 0 otherwise which $i \in \{1,2,3, \dots ,79\}$ is the index of each subject; $k \in \{2,3\}$ are the indexes of treatment where the 2nd and 3rd treatments are HHT and LHT respectively. β_0, β_1 are constant term and coefficient. $D_{ik,2} = 1$ if $k = 2$ and $D_{ik,2} = 0$ otherwise.

According to the hypothesis, in the model, we expect $\beta_1 = 0$ which means the reciprocity rates in HHT and in LHT are equal. Table 3.3-2 shows the result which, at 0.1 level of significance, we accept that $\beta_1 = 0$. The result supports H1.

Table 3.3-2 Results of Testing H1.

Coefficient	Estimation (p-value)*	Interpretation (0.1 level of significance)
β_1	-0.13 (0.72)	$\beta_1 = 0$
n = 158, McFadden R-squared = 0.001, Prob(LR statistic) = 0.722		

* Two-tailed p-value

Table 3.3-3 Treatments with Low Cost and High Cost of Giving: LLT and LHT.

Name	a	b	c	d	e	Cost of giving $\delta = a - c$	Equal split
Low-payoff and low-cost treatment (LLT)	50	50	150	300	100	-100	Yes (with R choice)
Low-payoff and high-cost treatment (LHT)	50	50	50	300	100	0	No

3.3.2. Testing H2

This section tests H2: the reciprocity rate of low-cost treatment is lower than of high-cost treatment. First, it presents and discusses the treatments and then presents the result.

Treatments with low cost and high cost of giving: LLT and LHT

To test H2, two treatments were designed: one with a low cost of giving (LLT) and the other with a high cost of giving (LHT). The treatments are presented in Table 3.3-3. LLT has a negative cost of giving which is lower than zero. The negative cost means that continuing the game always benefits the giver. Also, other possible confounds are controlled by specifying $a = b, d = 300$ and $e = 100$.

The treatments still have one confound – the equal split – which is not controlled. However, introducing the effect of equal split to the returning choice R in low-cost treatment does not affect our analysis. To be precise, similar to that discussed in Fehr and Schmidt (1999), inequity aversion behavior makes a subject prefer the choice of an equal split to the choice of an unequal split. The effect of equal split is expected to increase reciprocity rate in LLT. Since, in our test, we expect the reciprocity rate in LLT to be less than in LHT according to the cost of giving, observing that the rate in LLT is less than in LHT implies that the effect of cost induces stronger reciprocity than the effect of the choice of an equal split.

Result

According to H2: reciprocity rate of low-cost treatment is lower than that of high-cost treatment, we expect the rate of LLT to be less than that of LHT. As presented in Figure 3.3-1, the rate of LLT is 20% and that of LHT is 29% which is substantially different. To

Table 3.3-4 Results of Testing H2.

Coefficient	Estimation (p-value)*	Interpretation (0.1 level of significance)
α_1	-0.48 (0.19)	$\alpha_1 < 0$
n = 158, McFadden R-squared = 0.009, Prob(LR statistic) = 0.196		

* Two-tailed p-value

Table 3.3-5 Contingency Table Between LHT and LLT and Conditional Probability RR.

		LLT		Conditional probability of returning in high-cost treatment given returning in low-cost treatment (RR)*
		R	T	
LHT	R	14	9	87.5% (0.16)
	T	2	54	

* Two-tailed p-value is provided in parenthesis.[15]

statistically confirm the significance of the difference, we apply a logistic regression model as presented in (3.3-2):

$$\ln\left(\frac{Y_{ij}}{1-Y_{ij}}\right) = \alpha_0 + \alpha_1 D_{ij,1} + \mu_{ij} \qquad (3.3-2)$$

where Y_{ij}= 1 if the decision of i^{th} subject in j^{th} treatment is returning R and = 0 otherwise; $i \in \{1,2,3,\ldots,79\}$ is the index of each subject; $j \in \{1,3\}$ are the indexes of treatment where the 1st and 3rd treatments are LLT and LHT respectively. α_0, α_1 are constant term and coefficient. $D_{ij,1} = 1$ if $j = 1$ and $D_{ij,1} = 0$ otherwise.

According to the hypothesis, in the model, we expect $\alpha_1 < 0$ which means the reciprocity rate in LLT is less than that in LHT. Note that this is a one-sided hypothesis. Table 3.3-3 shows that from the result – at a 0.1 level of significance – we accept that $\alpha_1 < 0$. The result supports H2.

3.3.3. Testing H3

This section tests H3: a subject who reciprocates in low-cost treatment will reciprocate in high-cost treatment. In other words, we expect 100% of subjects who reciprocate (or choose returning R) in low-cost treatment will also reciprocate in high-cost treatment. To test the hypothesis, we apply data from LLT and from LHT to construct a 2 by 2 contingency table as presented in Table 3.3-5. (To test H3 and H4, we apply a contingency table as it is more appropriate and easier to understand the analyses than other methods like regression).

15 The Wilcoxon signed-rank test was applied to test H3 and H4.

Table 3.3-6 Contingency Table Between LHT and LLT and Conditional Probability TR.

		LLT		Conditional probability of return in high-cost treatment given return in low-cost treatment (TR)*
		R	*T*	
LHT	*R*	14	9	96.4%
	T	2	54	(0.16)

* Two-tailed p-value is provided in parenthesis.

To test the hypothesis, we developed a conditional probability RR to measure the conditional probability of return in high-cost treatment given return in low-cost treatment. According to the hypothesis, we expect RR to be 100%. Testing against the null hypothesis that RR is equal to 100%, at a 5% level of significance, we accept that RR is equal to 100%. The result supports H3. (Also note that this is a one-sided hypothesis).

3.3.4. Testing H4

This section tests H4: a subject who does not reciprocate in high-cost treatment will not reciprocate in low-cost treatment. In other words, we expect 100% of subjects who do not reciprocate (or choose taking *T*) in low-cost treatment to not reciprocate in high-cost treatment. To test the hypothesis, we applied data from LLT and from LHT to construct a 2 by 2 contingency table as presented in Table 3.3-6.

To test the hypothesis, we developed a conditional probability TR to measure the conditional probability of taking in low-cost treatment given taking in high-cost treatment. According to the hypothesis, we expect TR to be 100%. Testing against the null hypothesis that TR is equal to 100%, at 5% level of significance, we accept that RR equal to 100%. The result supports H4. (Also note that this is a one-sided hypothesis).

3.4. Conclusions

This chapter presents the theoretical relationships between cost of giving, intention of giver and positive reciprocity. The analysis shows a positive relationship among factors. Then, it presents experimental results from testing the theoretical relationship. The results strongly support the relationship.

Besides the contributions to theoretical and behavioral understanding, the results in this study can be put into practice. For instance, since the cost of giving implies altruistic intention and induces positive reciprocity, it provides an implication which is similar to *sacrificing* – one who sacrifices himself (as a costly action) for the goodness of others will be positively (and hugely) rewarded for his sacrifice with (for instance) fame, power, money, and social position as a hero! In other words, if you want to be rewarded for your action, others must know that the action was costly and for the sake of their well-being.

For further study, a qualitative study, for example with interviews, is necessary to deeply explore the relationship between the cost of giving, giver's intention and positive reciprocity. Moreover, up until this study, at least three aspects of intention have been explored: ability to make a decision (McCabe et al., 2003; Falk et al., 2008), motivation (Stanca et al., 2009), and cost of giving in this study; it is possible that another may arise with a new aspect to be explored.

CHAPTER IV
PREDICTION PERFORMANCE OF DK MODEL[16]

Traditionally, economists model an agent as a self-interested type, or *selfish model*. Much evidence from experimental studies showed that the selfish model does not explain behavior in most interactions. For instance, in the dictator game where the dictator decides to split the amount of money for himself and his follower. In the selfish model, the dictator should take all the money. But in experiments, a 70-30 share was the most selected option (Engel, 2011).

In the *reciprocal situation*, whereby a receiver returns a giver favors, the selfish model also fails to explain why reciprocity happens. For instance, Dufwenberg and Gneezy (2000) applied a lost wallet game in which the agent – who lost his wallet – decides how much money he will return to the wallet finder. According to the selfish model, the agent should not return the finder anything. However, the study found that the expectation of the agent of how much money the finder would like in return determines his decision.

Since the failure of the selfish model, a bunch of studies have proposed new *reciprocity models* which provided a better fit to evidence. Fehr and Schmidt (1999), Dufwenberg and Kirchsteiger (2004) and Falk and Fischbacher (2006) are examples of studies which proposed reciprocity models.

These reciprocity models show how an economic agent derives his utility in a reciprocity-related interaction. For instance, the reciprocity model proposed by Dufwenberg and Kirchsteiger (2004), or the *DK model*, explains that a receiver is more likely to reciprocate positively if he perceives that the giver gave him kindness. In other words, the perception of giver's kindness affects the receiver's utilities and decision.

When the existing literature tested their proposed models' validity, they showed the fitness of the models with existing data. For instance, Falk and Fischbacher (2006) collected data from questionnaires to develop their reciprocity model. The fitness of the proposed model with questionnaire data, together with data from other studies, appears to work well. Also, the model is intuitively reasonable. However, it is still questionable whether the model is still valid with new sets of data.

More precisely, we are questioning the model's performance in *predicting future decisions*. Besides the power to explain the past, the power to predict the future is another important aspect of any model. To illustrate the issue, think about a model of which its

[16] This study was accepted for publication as "Performance of a Reciprocity Model in Predicting a Positive Reciprocity Decision," in a forthcoming issue of Chulalongkorn Economic Journal.

parameters were estimated by fitting with existing data. The model may fail to fit with the data in the future since the parameters that determine future data may not be the same that determined the previous data.

This study aims to test the DK model's prediction performance. The model was selected for several reasons such as its simplicity (which is discussed further in section 4.1.). In this study, we measured the DK model's performance and compare it with other alternative prediction methods as benchmarks.

In this chapter, we discuss the DK model in section 4.1. In section 4.2.,we presenthow the DK model predicts decisions. In section 4.3., we detail how to design an experiment which can test the DK model's performance. In section 4.4.,we present the results. Finally, the chapter ends with a conclusion.

4.1. The DK Model

This section provides a brief introduction to the DK model proposed by Dufwenberg and Kirchsteiger (2004). (See Appendix A.2 for more details about the model).

The DK model is a reciprocity model that explains how an agent derives his utility, which affects his decisions, in a reciprocity-related situation.[17] Reciprocity models can be classified into two types: traditional and psychological. First, a *traditional* reciprocity model is a model which explains how an agent derives his utility from *material payoffs*, or monetary payoffs and physical outcomes. The altruistic model, inequity aversion model, equity-reciprocity-competition model are examples of traditional reciprocity models.[18]

Second, the *psychological* reciprocity model explains how an agent derives his utility from material payoffs and *psychological payoffs* as the payoffs from emotional experience in the situation. For instance, the DK model proposed that an agent is more likely to reciprocate if he perceives kindness (as a kind of psychological payoff) from his partner's actions. In another example, Battigalli and Dufwenberg (2007) proposed that the agent reciprocates to avoid any feelings of guilt (as another kind of psychological payoff).

In this study, the DK model is selected since: i) it is a psychological reciprocity model. A psychological model is more interesting since much evidence has supported emotional experience as playing an important role in reciprocity (e.g. Dufwenberg and Gneezy (2000)). ii) Comparison with other psychological reciprocity models, the DK model has only one parameter – the *reciprocity parameter* – which makes the model the simplest to be applied for predictions. More precisely, since a model can perform a prediction if we know the model's parameters from estimation, estimating one parameter is simpler than estimating more than one parameter.

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[17] See section 2.2.3. for details on the reciprocity model.

[18] See Fehr and Schmidt (1999) for the inequity-aversion model and Bolton and Ockenfels (2000) for the equity-reciprocity-competition model.

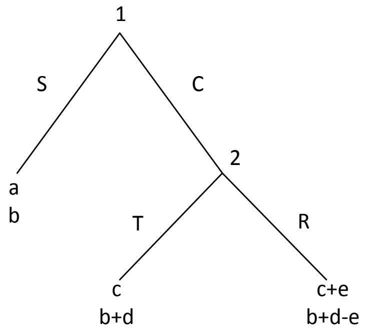

Figure 4.2-1 Positive-Reciprocity Trust Game.

4.2. DK Model’s Prediction in Positive-Reciprocity Trust Game

In this section, we apply the DK model to predicting reciprocity in the *positive-reciprocity trust game*. The game, as presented in Figure 4.2-1, models a positive-reciprocity situation; the giver (as the first player) gives the receiver (as the second player) favors and the receiver returns the giver favors.

In the game, the giver decides whether to stop (S) or trustfully continue (C) the game. If he continues, he gives the receiver d additional *monetary payoffs* and his monetary payoffs are changed from a to c. The receiver, after observing the continuation of the giver, decides whether to selfishly take (T) all additional monetary payoffs (which yields him $b + d$ monetary payoffs) or reciprocally return (R) e monetary payoffs, which is $e < d$. (which yields the giver and himself $c + e$ and $b + d - e$ monetary payoffs respectively). Also, note that the payoff structure (a, b, c, d, e) specifies monetary payoffs, not the *utility* which agents derive and though which determine decisions.

Next, to see how the DK model predicts the reciprocity of the receiver, we analyze the receiver’s best response function in the positive-reciprocity trust game. (See Appendix A.3 for the details of the derivation of the best response function). We simply follow the DK model and get the best response function as presented in (4.2-1):

$$BR_2 = \begin{cases} taking\ if\ 0 \le \emptyset_2 \le \dfrac{2}{d} \\ returning\ if\ \emptyset_2 \ge \dfrac{2}{d-e} \end{cases} \qquad (4.2-1)$$

where $\emptyset_2 \ge 0$ is the receiver’s *reciprocity parameter*; d and e are specified in the payoffs of the game as presented in Figure 4.2-1.

In the DK model, the reciprocity parameter represents how much an agent is emotionally sensitive in a reciprocity-related situation. If he is sensitive, he is likely to make a reciprocal return to givers. If he is not sensitive, he is likely not to. Notice that in the case that the agent is absolutely not sensitive – his parameter is $\emptyset_2 = 0$ – it implies that he is the selfish type and does not always return in any reciprocity-related situation.

From (4.2-1), the DK model predicts that the receiver will reciprocally return the giver if his reciprocity parameter is sufficiently high, $\emptyset_2 \geq \frac{2}{d-e}$. In contrast, he will choose taking if his reciprocity parameter is low, $0 \leq \emptyset_2 \leq \frac{2}{d}$.[19]

From the game, as presented in Figure 4.2-1, d is the additional monetary payoff that the giver gives the receiver from his continuing and e is the amount of monetary payoffs that the receiver returns the giver. Notice that the receiver's best response depends only on d and e. Intuitively, the result shows that, given a receiver with some value of reciprocity parameter, if the returned payoffs e are fixed the receiver is more likely to return when the additional payoff d is increased. Also, if the additional payoff d is fixed, the receiver is less likely to return when the returned payoffs are increased.

4.3. Experimental Design

In the previous sections, we introduced the DK model and its prediction in the positive-reciprocity trust game. From (4.2-1), we can see that the DK model predicts that a receiver who has a low reciprocity parameter, or type, will not reciprocate, and that a receiver who has a high type will.

In this section, we discuss how to design an experiment to test the DK model's prediction performance. In brief, two scenarios of positive-reciprocity trust game were designed which yield the same receiver's best response function. Then the subject, in the receiver role, made decisions in both scenarios. If the DK model makes a correct prediction, the decisions in both scenarios must be identical; the subject must choose returning in both scenarios or taking in both.

The design is explained in detail, as follows, in two sub-sections. First, a simple case is applied to illustrate the design method. In the case, we apply a one-player game and altruistic model. Then, in the second sub-section, we apply the cases which this study concerns: those of the positive-reciprocity trust game and DK model.

Simple Illustration: One-Player Game and Altruistic Model

This section presents a simple case to illustrate how we design scenarios to test a model's prediction performance. Here, we apply the altruistic model and two one-player games (as presented in Figure 4.3-1) as our scenarios.

The scenarios are different in how the *monetary payoffs* of each outcome are specified. In each scenario, the first player as a dictator makes a decision that determines the

[19] Notice that $\emptyset_2 \geq 0$ but, from (4.2-1), the interval $\emptyset_2 \in (X, Y)$ is missing. The missing interval exists in the best response if we allow mixed strategy and belief spaces.

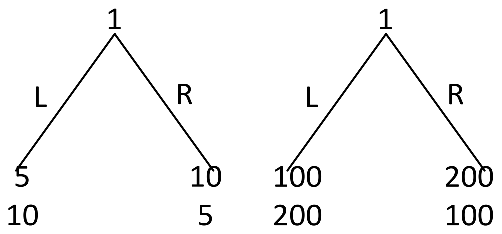

Figure 4.3-1 One-Player Games in Simple Illustration

outcome. The dictator's decision – either left (L) or right (R) – affects himself and his follower (the second player).

In the illustration, we test the altruistic model's prediction performance. That is, the dictator's altruistic utility function is $u_1(z_1;\theta_1) = m_1(z_1) + \theta_1 m_2(z_1)$ where $z_1 \in \{L, R\}$ is the dictator's decision, $\theta_1 \geq 0$ is the *altruistic parameter* (or *type*) of the dictator, m_1 is the dictator's monetary payoffs and m_2 is the follower's monetary payoffs.

Note that the game, as presented in Figure 4.3-1, specifies the monetary payoffs at each outcome, but the dictator determines his decision according to his utility. If the dictator chooses left, on left side of Figure 4.3-1, his monetary payoffs $m_1(L) = 5$ and his utility $u_1(L;\theta_1) = 5 + 10 * \theta_1$ which depends on his type.

Then, to see how the altruistic model predicts the dictator's decision, we characterize the dictator's best response function. Consider the game on the left side of Figure 4.3-1. Since his utility payoffs from choosing left is

$$u_1(L;\theta_1) = 5 + 10 * \theta_1,$$

and, his utility payoffs from choosing right is

$$u_1(R;\theta_1) = 10 + 5 * \theta_1,$$

the dictator's best response is choosing left when $u_1(L;\theta_1) \geq u_1(R;\theta_1)$ and choosing right when $u_1(R;\theta_1) \geq u_1(L;\theta_1)$. Equation (4.3-1) presents the best response function.

$$BR_1 = \begin{cases} L \ if \ \theta_1 \geq 1 \\ R \ if \ \theta_1 \leq 1 \end{cases} \qquad (4.3-1)$$

Notice that the dictator's decision depends on his type. If a dictator has high type ($\theta_1 \geq 1$), he will choose left; if he has low type ($\theta_1 \leq 1$), he will choose right. Hence, to be able to predict his decision, we must know his type.

We simply learn each subject's (as the dictator role) type by letting him make a decision in the left scenario. For instance, if a subject chooses left in the scenario it implies that he has high type ($\theta_1 \geq 1$). We call this learning scenario *conditional scenario*.

Then, to test the model's performance another *equivalent* scenario was designed for the conditional scenario. In this design both scenarios are equivalent if the best response functions of scenarios are the same. For instance, the game on the right of Figure 4.3-1 is equivalent to the game on the left.

To show this, we derive the dictator's best response function of the game on the right. Similarly, in the right game, the dictator derives $u_1(L;\theta_1) = 100 + 200 * \theta_1$ if he chooses left and $u_1(R;\theta_1) = 200 + 100 * \theta_1$ if he chooses right. Then, his best response is to choose left if $u_1(L;\theta_1) \geq u_1(R;\theta_1)$ and to choose right if $u_1(R;\theta_1) \geq u_1(L;\theta_1)$. Hence, we derive the dictator's best response of the game on the right which is the same as on the game on the left, as presented in (4.3-1). We call the game on the right a *tested scenario.* Since both conditional and tested scenarios provide the same best response function of the dictator, if the altruistic model is correct we expect each subject to make the same decisions in both treatments. That is, we expect to see a subject who chooses left in a conditional scenario to also choose left in a tested scenario; we expect to see a subject who chooses right in a conditional scenario to also choose right in a tested scenario. Else, the model is incorrect if the decisions are not the same.

To summarize, to make a model perform predictions we design a conditional scenario that provides the same best response of a focused role as in the tested scenario. Hence, the model implies that each subject in the focused role should have identical decisions in both conditional and tested scenarios.

It is worth noting that this design can be applied to any model that has more than one parameter. For instance, if a model has two parameters, the design applies two conditional scenarios to learn the parameters.

However, the design has its weakness: i) a model that is tested for its performance must be explicitly specified, like the altruistic model (and the DK model). Hence, the model's functional form affects the performance. ii) Since we infer a future decision from a past decision, the assumption of *type-invariance* across scenarios is required. iii) Repetition is unavoidable since each subject makes at least two decisions (in conditional and tested scenarios) in similar games. The repetition can generate unsatisfactory data quality.

Positive-Reciprocity Trust Game and DK Model

Now, we turn to focus of this study – the positive-reciprocity trust game and DK model. This section presents how the designed scenarios as presented in Table 4.3-1 (see positive-reciprocity trust game in Figure 4.2-1) can be applied to test the DK model's performance.

By applying the same concepts presented in the previous section, this study designed six scenarios of positive-reciprocity trust game (as presented in Table 4.3-1) that have the same best response of the receiver. Recall the best response function of receiver in (4.2-1): $BR_2 = \begin{cases} taking\ if\ 0 \leq \emptyset_2 \leq \frac{2}{d} \\ returning\ if\ \emptyset_2 \geq \frac{2}{d-e} \end{cases}$. The response depends on d and e. Notice that all designed

Table 4.3-1 Conditional and Tested Scenarios of Positive-Reciprocity Trust Game.

Conditional/Tested Scenario	Number	a	b	c	d	e
Conditional	1	100	100	100	300	100
Tested	2	50	50	50	300	100
	3	200	200	200	300	100
	4	0	0	0	300	100
	5	50	50	150	300	100
	6	-200	-600	-200	300	100

scenarios have equal $d = 300$ and $e = 100$. Hence, the best response function is the same for all scenarios.

The designed scenarios are different in how we specified the monetary-payoff structure a, b and c. By varying the payoff structure, we can test how the DK model performs when other exogenous factors are introduced. In the 1st-4th scenarios, they have $a = b = c$. But, the level of monetary payoffs is different. To be exact, the 4th scenario has the lowest payoffs, then 2nd, 1st and 3rd scenarios respectively. The 5th scenario has $a = b$ but $a < c$. The difference between a and c represents the cost of continuing in the positive-reciprocity trust game (for more details see Bhirombhakdi and Potipiti (2012A)). Hence, compared to the 1st-4th scenarios, the 5th scenario has a different cost of continuing. Lastly, the 6th scenario is the only one that has negative monetary payoffs. In other words, subjects make decisions to lose, rather than decisions to gain in other scenarios. However, since d and e are positive, the scenario still captures the essence of positive reciprocity.

To test the DK model's performance, each subject (in the receiver role) makes a decision in the first scenario as the conditional scenario. Then, we classify the subject into the high-type group if he chooses to return (since choosing to return implies that his type is greater than $\frac{2}{d-e}$); and we classify him into low-type group if he chooses to take (since choosing to take implies that his type is in between zero to $\frac{2}{d}$).

Then, we let the subject make another decision in five tested scenarios and compare the decisions with his previous decision in the conditional scenario. If the DK model is correct a high-type subject should choose to return in the tested scenario or a low-type subject should choose to take in the tested scenario; otherwise, the model is incorrect.

4.4. Results

This section presents the results. The data of 79 subjects were collected from the experiment (see the experiment protocol in Appendix A.1.). To test the DK model's performance, the data was analyzed in two sections: first, the DK model's rate of correct prediction, or *accuracy rate*; second, benchmarking of the DK model's accuracy rate with other alternative prediction methods.

Table 4.4-1 2 by 2 Contingency Table of Conditional (1st) Scenario and Tested (2nd) Scenario.

		Tested (2nd) Scenario		Accuracy Rate
		R	T	
Conditional (1st) Scenario	R	16	5	$\frac{16+51}{79} \approx 85\%$
	T	7	51	

Table 4.4-2 Accuracy Rate.

	Tested scenario				
	2nd	3rd	4th	5th	6th
Accuracy Rate	85%	82%	81%	81%	75%

4.4.1. DK Model's Rate of Correct Prediction (Accuracy Rate)

This section presents the results of testing the DK model's rate of correct prediction, or *accuracy rate*. The accuracy is analyzed in two sub-sections: first, we measure the accuracy rate in predicting decisions in each tested scenario; second, we statistically test whether the accuracy rate equals to 100% as predicted by the DK model (or not).

Measuring Accuracy Rate

To measure the accuracy rate in predicting decisions in each tested scenario, we applied data from the conditional (1st) scenario and one tested scenario to construct a 2 by 2 contingency table. For instance, Table 4.4-1 shows how to measure the accuracy rate in predicting decisions in the 2nd tested scenario.

In the table, from the data, the 79 subjects were classified into four categories according to their decisions in conditional and tested scenarios. Sixteen subjects chose to return in both scenarios, 51 subjects chose to take in both scenarios, 7 subjects chose to take in the conditional scenario but to return in the tested scenario and 5 subjects chose to return in the conditional scenario but take in the tested scenario.

According to the design, recall that the DK model predicts that each subject should make the same decisions in both scenarios. In other words, the model predicts correctly if a subject chooses to return in both scenarios or take in both.

Hence, we measured the *accuracy rate* by counting the percentage of subjects who chose to return in both scenarios or take in both. From the table, 16 subjects chose return-return and 51 subjects chose take-take from a total of 79 subjects. Hence, the accuracy was $\frac{16+51}{79} \approx 85\%$.

Table 4.4-2 presents the accuracy rate in predicting decisions in each tested scenario. The measurements show the accuracy was about 80% when predicting 2nd-5th scenarios, but

Table 4.4-3 Results of Statistical Test of Accuracy.

Tested scenario: z in (4.4-1)	$\hat{\alpha}_{0z}$ (p-value)	$\hat{\alpha}_{1z}$ (p-value)	R^2	n	F-statistic (H_0: $\alpha_{0z} = 0$ and $\alpha_{1z} = 1$)	Interpretation (at 0.05 level of significance)
$z = 2$	0.24* (0.014)	0.64** (0.000)	0.39	79	7.078	Accuracy rate is not 100%
$z = 3$	0.29** (0.005)	0.58** (0.000)	0.31	79	8.616	Accuracy rate is not 100%
$z = 4$	0.05 (0.315)	0.71** (0.000)	0.40	79	9.505	Accuracy rate is not 100%
$z = 5$	0.48** (0.000)	0.44** (0.000)	0.23	79	11.970	Accuracy rate is not 100%
$z = 6$	0.86 (0.000)	0.11 (0.185)	0.04	79	62.415	Accuracy rate is not 100%

P-value shows two-tailed p-value.
* Coefficient is significant at the 0.05 level (two-tailed).
** Coefficient is significant at the 0.01 level (two-tailed).

75% when predicting the 6th scenario. According to the design, we expect that if the DK model is perfectly correct then the accuracy rate should be 100%; since every subject should choose only to return in both scenarios or to take in both. Even though the results show that the accuracy is less than 100%, the results will be statistically confirmed in the following section.

Statistical Test of Accuracy Rate

According to the design, we expect each subject to make the same decisions for both conditional and tested scenarios. In other words, we expect the accuracy rate to be 100%. To test whether the accuracy rate is significantly 100% or not, a linear probability regression model is applied as presented in (4.4-1):

$$T_{jz} = \alpha_{0z} + \alpha_{1z}T_{j1} + \varepsilon_{jz} \qquad (4.4-1)$$

where T_{jz} = 1 if the subject j^{th} chooses to take T in the z^{th} scenario and = 0 otherwise; $j \in \{1,2,3,\ldots,79\}$ is the index of each subject and $z \in \{2,3,4,5,6\}$ is the index of each tested scenario; T_{j1} = 1 if the subject j^{th} chooses to take T in the conditional scenario and = 0 otherwise. α_{0z} and α_{1z} are constant and coefficient of the corresponding scenario z^{th}. ε_{jz} is the disturbance of the subject j^{th} in the corresponding scenario z^{th}.

According to the (4.4-1) model, if the accuracy rate is 100%, we expect $\alpha_{0z} = 0$ and $\alpha_{1z} = 1$ for each z^{th} tested scenario. To test the hypothesis, we simply applied the F-test. The results of regression (estimated by least squares method and White heteroskedasticity consistent covariance) and F-test are presented in Table 4.4-3.

According to the (4.4-1) model, the F-test tests the null hypothesis in which $\alpha_{0z} = 0$ and $\alpha_{1z} = 1$. At a 0.05 level of significance, the critical value of F-statistic, critical F(2,77), is

3.115. Since the calculated F-statistic from the test was greater than the critical F(2,77), we *rejected* the null hypothesis. That is, the accuracy rate was not 100% statistically.

From the results, we can see that the DK model has an approximately 80% correct prediction rate. This implies that the DK model is not perfect – there are some areas about which the model fails to capture the behavior. In other words, there is room for improvement in a new model to yield better performance than the DK model.

In addition to the accuracy rate, the next section compares the accuracy rate of the DK model with other alternative prediction methods. In order to evaluate whether the performance of the DK model is good or bad, benchmarking helps us in the evaluation.

Before ending this section, it is worth discussing the result of the accuracy of the 6th scenario which was less than the accuracy of other scenarios. Notice that the accuracy of the 6th scenario was the only scenario with a *negative-monetary-payoffs structure*; while the conditional and other tested scenarios have a positive-monetary-payoffs structure (see Table 4.3-1). The decision in the 6th scenario creates loss to the subject's monetary payoffs rather than gain to the monetary payoffs in the other scenarios. However, the 6th scenario still captures the essence of positive reciprocity since d and e are positive. Recall that, according to the design, we expected the decisions in the conditional and 6th tested scenario. The result that the accuracy of the 6th scenario was lower than that of other scenarios implies that inferring a subject's decision in a negative-point-structure scenario (the 6th scenario) from his decision in a positive-point-structure scenario (the conditional scenario) is not possible through the DK model.

4.4.2. Benchmarking with alternative prediction methods

In the previous section, we measured the accuracy rate of the DK model. Even though the accuracy seems pretty high at 80%, we cannot conclude that the DK model has good performance. To evaluate the goodness of the model performance, we need to benchmark its accuracy rate with that of other alternative prediction methods.

In this section, we benchmark the DK model with three alternative prediction methods: *majority method*, *DG method* and *Personal-info method*. These methods are selected for benchmarking with the DK model since they are simpler to apply to prediction than to apply the DK model. Hence, if the DK model performs well, we expect the DK model to provide higher accuracy than the other methods provided.

Comparisons of the DK model were presented in three sub-sections, namely, with the majority method, with the DG method and with the Personal-info method.

4.4.2.1. DK Model VS Majority Method

The *majority method* precisely predicts the subject's decision by applying the major proportion of the population. For instance, recall from Table 4.4-1 that in the conditional

Table 4.4-4 Accuracy Rates from DK Model and Majority Method.

	Tested scenario				
	2nd	3rd	4th	5th	6th
Accuracy from DK model	85%	82%	81%	81%	75%
Accuracy from Majority Method	71%	71%	57%	80%	94%
Difference	14%	11%	24%	1%	-19%

Table 4.4-5 Results of Comparing between DK Model and Majority Method.

Tested scenario: z in (4.4-1)	$\hat{\alpha}_{0z}$ (p-value)	$\hat{\alpha}_{1z}$ (p-value)	R^2	n	Interpretation (at 0.05 level of significance)
$z = 2$	0.24* (0.014)	0.64** (0.000)	0.39	79	DK model is more accurate
$z = 3$	0.29** (0.005)	0.58** (0.000)	0.31	79	DK model is more accurate
$z = 4$	0.05 (0.315)	0.71** (0.000)	0.40	79	DK model is more accurate
$z = 5$	0.48** (0.000)	0.44** (0.000)	0.23	79	DK model is more accurate
$z = 6$	0.86** (0.000)	0.11 (0.185)	0.04	79	DK model is not more accurate

P-value shows two-tailed p-value.
* Coefficient is significant at the 0.05 level (two-tailed).
** Coefficient is significant at the 0.01 level (two-tailed).

scenario21 subjects chose returning and 58 subjects chose taking. In other words, the majority chose taking at the proportion of $\frac{58}{79} \approx 73\%$. The majority method predicts that a subject chooses taking with 73% accuracy.

As mentioned, predicting decisions by applying the majority method is simpler than applying the DK model. This is because the majority method requires no mathematical model and requires no learning of each subject's type.

Table 4.4-4 presents the results of accuracy rates from applying the DK model and applying the majority method. Also, the table presents the difference between the DK model's accuracy rates and those of the majority method. The results show that the DK model predicts more accurately than the majority method in the 2nd-5th scenarios but less accurately in the 6th scenario.

To statistically test the difference of accuracy between the methods, we applied the linear probability model (4.4-1) as presented in the previous section. We simply estimated the parameters and did the t-test whether $\alpha_{1z} = 0$ or not. If the DK model predicts more accurately than the majority method, we expect $\alpha_{1z} \neq 0$.

Table 4.4-5 presents the results from the t-test. Equivalently, the result of the t-test, that has the null hypothesis which $\alpha_{1z} = 0$, is presented by the p-value of $\hat{\alpha}_{1z}$. At a 0.05 level of significance, if the p-value is equal or less than 0.05 then we reject the null hypothesis.

From the results, for the 2nd-5th scenario, since the p-value of $\hat{\alpha}_{1z}$ of each scenario was less than 0.05, we reject the null hypothesis at a 0.05 level of significance. In other words, the DK model predicts more accurately than the majority method. For the 6th scenario the p-value was 0.185, which is greater than 0.05, so we do not reject the null hypothesis. In other words, this implies that the DK model predictsless accurately than the majority method.

Hence, we can conclude that the DK model has better performance than the majority method when predicting across the 2nd-5th positive monetary-payoffs scenarios. However, in predicting the negative monetary-payoffs scenario 6th, the DK model performs less well than the majority method since the majority method has very high accuracy at 94%.

4.4.2.2. DK Model VS DG Method

This section compares the performance of the DK model with that of the DG method. The DG method predicts a subject's decision in a tested scenario by applying his decision in a dictator game, or DG. Equivalent to the conditional scenario, the dictator game is the game in which we learn a subject's reciprocity type.

The dictator game has one decision maker that affects the monetary payoffs of two players. The decision maker, or the dictator, makes a decision as to how many of the monetary payoffs he will take for himself from the total amount, while the other player, as the dictator's follower, takes what is leftover. In this experiment, the dictator split 200 total monetary payoffs for himself and his anonymous follower. Also, only a non-negative integer number was allowed for the split (from 0 to 200).The dictator's decision is believed to be the proxy of his reciprocity since the dictator game is the simplest game that represents the interaction between economic agents concerned with social norms (including reciprocity), fairness, altruism, and so on (Guala and Mittone, 2010). Intuitively, a dictator who takes most of the share is believed to be a selfish individual concerned less about reciprocity. Also, theoretically, we can show the relationship between the decision in a dictator game and the reciprocity parameter in the DK model (see Appendix A.4).

Comparison of the performance between the DK model and DG method is now presented in two sub-sections: how to measure the accuracy rate of the DG method and a comparison of the accuracy rate of DG method with that of the DK model.

<u>Measuring Accuracy Rate of DG Method</u>

For each tested scenario, the process of measuring the accuracy rate involved four steps. First, we randomly separated the data of 79 subjects into two groups: 39 subjects in the first group and 40 subjects in the second group. Second, we estimated the linear probability model by applying data from the first group. Third, we applied the estimated model to predict the decisions of subjects in the second group. Last, we measured the accuracy rate by comparing the real decisions and predicted decisions.

The linear probability model is presented in (4.4-2),

$$T_{iz} = \beta_{0z} + \beta_{1z} DG_i + \mu_{iz} \qquad (4.4-2)$$

Table 4.4-6 Regression Results of DG Method.

Tested scenario: z in (4.4-3)	$\hat{\beta}_{0z}$ (p-value)	$\hat{\beta}_{1z}$ (p-value)	R^2	n
$z = 2$	0.116 (0.593)	0.004** (0.003)	0.16	39
$z = 3$	0.118 (0.595)	0.004** (0.007)	0.12	39
$z = 4$	-0.251 (0.226)	0.005** (0.000)	0.22	39
$z = 5$	0.288 (0.217)	0.003* (0.035)	0.11	39
$z = 6$	0.652** (0.016)	0.002 (0.318)	0.06	39

P-value shows two-tailed p-value.
NA means not available.
* Coefficient is significant at the 0.05 level (two-tailed).
** Coefficient is significant at the 0.01 level (two-tailed).

where T_{iz} = 1 if the subject i^{th} chooses taking T in the z^{th} scenario and = 0 otherwise; $i \in \{1,2,3,\ldots,39\}$ is the index of each subject in the first group;[20] $z \in \{2,3,4,5,6\}$ is the index of each tested scenario. DG_i is the monetary payoffs that the subject i^{th} kept for himself in the dictator game. β_{0z} and β_{1z} are constant and coefficient respectively. μ_{iz} is disturbance.

To measure the accuracy rate, we estimated (4.4-2)by applying data from the first group. Table 4.4-6 presents the regression results. Then, we use the estimated coefficients to find the fitted value of each subject's decision in the second group. The fitted model is as presented in (4.4-3),

$$\hat{T}_{hz} = \hat{\beta}_{0z} + \hat{\beta}_{1z} DG_h \qquad (4.4-3)$$

where $\hat{T}_{hz}$ is the fitted value of each h^{th} subject in the z^{th} tested scenario; $h \in \{40,41,42,\ldots,79\}$ is the index of subjects in the second group. $\hat{\beta}_{0z}$ and $\hat{\beta}_{1z}$ are the estimated constant and coefficient. For instance, in the 2[nd] tested scenario, (4.4-3) is derived as (4.4-4),

$$\hat{T}_{h2} = 0.116 + 0.004 DG_h. \qquad (4.4-4)$$

From (4.4-4), we see that if a subject's decision in the dictator game is to take 96 monetary payoffs for himself, his fitted value of decision in the 2[nd] tested scenario is a 0.5 chance of choosing to take.

Since the fitted value can be any real number but the predicted decision is a pure strategy (either 0 or 1), we assign the predicted decision to be 1 if the fitted value is greater or equal to 0.5; otherwise, the predicted decision is zero.

20 The number of observations in the first group was assigned to each subject randomly by: assigning a random number which was drawn from a uniform distribution to each subject, ordering the subjects according to the assigned random number and assigning the number of observations according to the order.

Table 4.4-8 Accuracy of DK Model and DG Method.

	Tested scenario				
	2nd	3rd	4th	5th	6th
Accuracy of DK model	85%	82%	81%	81%	75%
Accuracy of DG Method	73%	78%	70%	83%	98%
Difference	12%	4%	11%	-2%	-23%

Therefore, the DG method (4.4-4) predicts that a subject will choose to take in the 2nd tested scenario (or the predicted decision is equal to 1) if he takes at least 96 monetary payoffs in the dictator game; otherwise, a subject chooses to return.

Last, we measured the accuracy rate of DG method by comparing the predicted decision and actual decision of subjects in the second group. For each tested scenario, we constructed a 2 by 2 contingency table of predicted and actual decisions of subjects in the second group; this process is similar to what we have done previously when measuring the accuracy rate of the DK model (see 4.4.1.).

Comparison of DK Model and DG Method

By applying the same process to each tested scenario, we measured the accuracy rate of the DG method. Table 4.4-8 presents the accuracy rates and compares them with of the DK model. The results show that the DK model predicted more accurately than the DG method in the 2nd-4th scenarios, but less accurately in the 5th and 6th scenarios.

4.4.2.3. DK Model VS Personal-Info Method

In this section, we compare the performance of the DK model with that of the last alternative method: the *Personal-info method*. Similar to the previous section, in this section, first we measured the accuracy rate of the Personal-info method and then compared the accuracy rate with that of the DK model.

Measuring the Accuracy Rate of the Personal-Info Method

The Personal-info method predicts a decision by applying the data of personal information including IQ scores, personality, attitude and socio-economic factors.In measuring accuracy, since in the experiment we collected many types of personal information from the questionnaire, in the first step, we needed to select the factors.Then, we applied a regression model determined by the selected factors to predict decisions and measured for accuracy; these steps were similar to those carried out previously in the DG method.

Measuring accuracy involved five steps. First, we randomly separated subjects into two groups: 39 subjects in the first group and 40 subjects in the second group. Second, for each tested scenario we selected the best-fit factors. Third, we estimated a linear probability model by applying data from the first group. Fourth, we applied the estimated model to predict the decisions of subjects in the second group. Last, we measured the accuracy rate by comparing the actual decisions and predicted decisions.

$$T_{iz} = \gamma_{0z} + \sum_{k=1}^{n} \gamma_{kz} x_{kiz} + \vartheta_{iz} \quad (4.4-6)$$

Equation (4.4-6) presents the linear probability model of the Personal-info method; T_{iz} = 1 if the subject i^{th} chooses taking T in the z^{th} scenario and = 0 otherwise; $i \in \{1,2,3,\ldots,39\}$ is the index of each subject in the first group; $z \in \{2,3,4,5,6\}$ is the index of each tested scenario. x_{kiz} where $k \in \{1,2,3,\ldots,n\}$ is the subject i^{th}'s selected factor in the z^{th} scenario; n is the total number of selected factors. γ_{0z} and γ_{kz} are constant and coefficients of the corresponding variables in the z^{th} scenario. ϑ_{iz} is disturbance.

In the second step, we selected the best-fit factors by applying the correlation and iterative drop-out method.[21] Then, in the third step, we estimated the model, of which the regression results are presented in Appendix A.5. (Since this study does not aim to explore determinants that affect decisions, the results are not discussed in detail). For instance, in the 3rd tested scenario, the result is presented in (4.4-7),

$$T_{i3} = 0.80 - 0.58ENN7_i + \vartheta_{i3} \quad (4.4-7)$$

where $ENN7_i$ is equal to 1 if the i^{th} subject has Enneagram of Personality Type 7; otherwise, it is equal to zero.

Then, in the fourth step, we applied the estimated model to predict the decisions of subjects in the second group. Similar to what we did in the DG method, for instance, in the 3rd scenario we found the fitted value of decision by applying (4.4-8),

$$\hat{T}_{p,h3} = 0.80 - 0.58ENN7_h \quad (4.4-8)$$

where $\hat{T}_{p,h3}$ is the fitted value of the decision (equal to 1 means choosing taking) of the h^{th} subject in the 3rd tested scenario (we use subscript "p" to differentiate the value from the fitted value from the DG method, $\hat{T}_{hz}$); $h \in \{40,41,42,\ldots,79\}$ is the index of subjects in the second group. Then, if $\hat{T}_{p,h3} \geq 0.5$ the model predicts that the subject will choose to take in the 3rd tested scenario; otherwise, he will choose to return.

In the last step, we measured the accuracy of the Personal-info method by comparing the predicted decision with the actual decision. Similarly, we applied a 2 by 2 contingency table to do the task.

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21 The study selected the factors x_k by: finding the Pearson product-moment correlation coefficient between the decision in the tested scenario and the personal information, selecting the factors that statistically showed correlation to the decision at 0.2 level of significance, regressing the selected factors in the model, dropping one factor with the most statistically insignificant and re-regressing the dropped-out model, repeating the dropping-out process until all factors in the model showed their coefficients were statistically significant at a level of 0.05.

Table 4.4-11 Accuracy of DK Model and Personal-Info Method.

	Tested scenario				
	2^{nd}	3^{rd}	4^{th}	5^{th}	6^{th}
Accuracy of DK model	85%	82%	81%	81%	75%
Accuracy of Personal-info method	75%	75%	60%	75%	98%
Difference	10%	7%	21%	14%	-23%

Comparison of DK Model and Personal-Info Method

Table 4.4-11 compares the accuracy rates of the DK model and Personal-info method. As can be seen from the results, the DK model had a higher accuracy rate than the Personal-info method for the 2^{nd}-5^{th} tested scenarios but lower accuracy rate for the 6^{th} scenario.

4.5. Conclusions

This study tested the DK model's performance in predicting positive-reciprocity decisions. A new approach to measuring the model's performance was introduced. In this approach, a scenario was designed to discover each subject's type and infer his future decisions in other scenarios from his type. Using this approach, we can measure the correct prediction rate, or accuracy rate, of the DK model. The results show that the model has an approximate 80% accuracy rate.

Since only the accuracy rate of the DK model is not sufficient in evaluating the goodness of the model, we further benchmarked the model's performance with other alternative prediction methods including the majority method, DG method and Personal-info method. The results show that the DK model had higher accuracy than the other methods in most scenarios. This implies that the DK model had good performance and that there was some room for further development.

For further study, there are many possibilities that could be explored. The limitations of the DK model could be explored in other scenarios. Other models' performance could also be investigated by applying our approach. Alternatively, the issues that are additionally addressed in this study could be addressed, such as what we observed in the 6^{th} scenario whereby the DK model failed to accurately predict decisions across scenarios with positive and negative monetary-payoff structures.

CHAPTER V
REVIEW OF AUCTION DESIGN FOR AN OBJECT WITH POSITIVE-EXTERNALITIES

In sell a masterpiece of fine art, the seller does not know its true value. She knows that if somebody is not interested, they'll place low value on it; while if somebody is interested they'll attach a high value to it. Suppose the seller sells the masterpiece at a fixed price in a famous art gallery (since he knows that in the art gallery, there are only high-value buyers). Doing so means there is a chance of the work not selling since buyers may visit the gallery randomly. Even if we assume that all buyers visit at the same time, (suppose the price is not too high) the seller can sell the masterpiece at that posted price which the obtainer may be more willing to pay. Hence, to get the highest amount, the seller should increase the price a little until there is only one last buyer who is willing to pay at the last posted price. This is a kind of *auction*.

An auction is a mechanism by which a seller sells his object to get higher revenue than selling at his vendor at a fixed price. One of the most important reasons behind an auction yielding higher revenue than selling at a vendor is that the auction places buyers in a *competitive environment*. Many potential buyers gather with different willingness to pay for the object. The buyers compete with each other under the auction rules to win and obtain the object. The winner is the buyer who offers (or bids) the highest payment. Since it is competitive, the buyers bid aggressively and more closely to the amount they are truly willing to pay.

This chapter first presents a broad picture of previous studies in auction design theory. Then, since this study focuses on designing an auction for an object with countervailing-positive externalities, the types of externalities in auctions are presented followed by a review of recent literature on auction design for an object with externalities.

5.1. Auction Design Theory

In this internet age, opening an auction on a website like "*eBay*" is very convenient. It simplifies the process in designing an auction in just a few steps:

1. Decide what object is to be sold.
2. Provide information about the object (e.g. general description, photos, condition).
3. Design your auction (including reservation price, duration, buyout option).

4. Clarify other rules and regulations (including shipping and return policies).

In economics, *auction design theory* is a special topic in mechanism design theory within the field of microeconomics related to asymmetric information. The main concepts of mechanism design theory are to theoretically study how to design a mechanism which produces specific outcomes the mechanism designer wants. For instance, in an auction, the designer is the seller and he wants the bidders to bid according to their *true* willingness to pay (or value); hence he can sell the object to the bidder with the maximum willingness to pay. Besides auction design theory, other special topics in the mechanism design theory include contract design theory, voting system design, and organizational design.

An auction, theoretically, is a *function* from the bidders' bids to each bidder's payment (or *payment rule*) and probability of obtaining the object (or *allocation rule*). For instance, the first-price sealed-bid auction specifies that the highest-bid bidder pays his own bid and obtains the object with one probability. Hence, each auction is different in how the payment and allocation rules are defined. The following are some examples of common and uncommon auctions.

Common Auctions:

- *English Auction* (a.k.a. open ascending price auction). In the auction, the seller sets the initial lowest price and lets buyers (or bidders) offer (or bid) their willingness to pay sequentially. Until there is no buyer offering a higher price, the highest-bid bidder pays his bid and obtains the object.
- *Dutch Auction* (a.k.a. open descending price auction). The seller sets a very high initial price and gradually decreases the price until it hits a buyer who is willing to pay.
- *First-price sealed-bid auction*. In this auction, all buyers (or bidders) simultaneously and secretly submit bids. The highest-bid bidder pays the amount equal to his bid and obtains the object.
- *Second-price sealed-bid auction* (a.k.a. Vickrey auction). All bidders simultaneously and secretly submit bids. The highest-bid bidder pays the amount equal to the second-highest bid (also called the second price) and obtains the object.

Uncommon Auctions:

- *Lowest unique bid auction*. Bidders secretly submit bids. Depending on the seller's rules, bids may be submitted simultaneously once or may be submitted multiple times. The winner is, when the auction is closed to accepting further bids, the bidder who submitted a unique and lowest bid. He pays an amount equal to his bid and obtains the object.
- *All-pay auction.* All bidders simultaneously pay their own bids. The highest-bid bidder obtains the object.
- *Buyout auction.* The seller sets a fixed price to sell the object and opens an auction to accept bids within the duration. If nobody pays the fixed price, when the duration ends, the highest-bid bidder pays his bid and obtains the object. If a bidder is willing to pay at the fixed price, he can*buyout* at the price before the duration ends.

Notice that each auction is different in their rules of allocation and payment. For instance, the second-price sealed-bid auction lets the winner pay the second price while others let him pay his own bid. The lowest unique bid auction allocates the object to the bidder whose bid is unique and lowest and he pays an amount equal to his bid while others allocate the object to the highest-bid bidder. Besides this, the mechanism of submitting a bid can differ among auctions. For instance, the sealed-bid-auction family lets bidders submit bids secretly while the English auction is different. The lowest unique bid auction allows bidders to re-submit bids, while the sealed-bid auction does not.

In economics, auction design follows similar steps as in eBay. However, economists look at it theoretically and mathematically. Economists design auctions which serve some specific purposes – not only for the highest revenue but also, sometimes, for the optimal social-welfare solution. The economic process of auction design is:

1. Decide what object is to be sold. Theoretically, it means what properties the object should have. It is a normal good, a good with negative externalities, a good with positive externalities, and so forth. Also, it means how many pieces of object will be sold: only one indivisible piece or many pieces. This step also links to how the bidders derive their utilities from each possibility of outcomes.

2. Provide information about the object. Theoretically, information is provided to bidders in three stages: ex-ante, interim and ex-post. *Ex-ante* means before the auction starts; *interim* means while the auction is running; *ex-post* means after the auction ends. Like the case of eBay, the auction designer should ex-ante provide all necessary information for the object.

3. Design the auction and clarify other rules and regulations. Like in eBay, all rules (including submitting bid mechanism, allocation, payment and other relevant rules) and regulations should be announced ex-ante. While the auction is running, no further changes can be made to those rules. *Commitment* to the rulesis the most important behavior of all agents in any mechanism: in this context, the seller and bidders.

4. Predict the outcome and evaluate it. In studying auction design, the designer has some objectives which he wants the auction to achieve. Mostly, an auction designer wants the auction to either: i) yield the highest ex-ante expected revenue, or ii) allocate the object efficiently (which means the one who values the most should obtain it). The designer evaluates whether the auction achieves the objectives by predicting the most plausible outcome from the auction. In economics, normally, we apply the concepts of equilibrium in predicting things. Here, it is applied as well. The designer can characterize the *equilibrium-bidding strategy* which is induced by the properties of object, information about the object which bidders know and the auction's rules and regulations.

Vickrey (1961) was the first to study auction design,[22] and this work remains the most famous in this field. He studied second-price sealed-bid auction and found that the auction can induce truth-telling. Another famous study is that of Myerson (1981),[23] who studied the optimal (meaning revenue-maximizing in this context) auction for a normal (without special properties such as externalities) and indivisible object. He found that the second-price sealed-bid auction with reservation price is the most revenue-maximizing auction. His research also

22 William Vickrey received a Nobel Prize in 1996.

23 Roger Myerson received a Nobel Prize in 2007.

generalized the *revenue equivalence theorem* which provides the condition that any two auctions can yield the same ex-ante expected revenue. (e.g., the first-price and second-price sealed-bid auctions yield the same expected revenue under some conditions).

There have been many studies carried out in the field of auction design theory. Each of them is different in how they model the situation (recall numbers 1-3 in the process of auction design as previously presented). Points which studies modeled differently are:

1. *Object*. Vickrey (1961) and Myerson (1981) modeled the auction for a normal and indivisible object. Some studies explored a multi-object auction (e.g. Vickrey (1961)), while others studied an object with externalities (e.g. Jehiel and Moldovanu (2000)).

2. *Bidder's utility function*. Most studies have addressed risk-neutral, symmetric and independent (one bidder does not relate to another) bidders (e.g. Vickrey (1961)). Myerson (1981) allowed for asymmetry. Holt (1980) explored risk aversion and Matthews (1987) explored constant absolute risk aversion, CARA. Milgrom and Weber (1983) explored interdependent (one bidder is related to others) case. Additionally, some studies introduced budget constraints to the model (e.g. Che and Gale (1998))

3. *Number of bidders*. The simple model applies two bidders (e.g. Jehiel and Moldovanu (2000)), while the general model applies certain n bidders (e.g. Myerson (1981)). Some studies have explored the effect of the uncertainty of a finite number of bidders. Harstad, Kagel and Levin (1990) explored a case with risk-neutral bidders, while McAfee and McMillan (1987) researched one with risk-averse bidders.

4. *Auction*. In studying auction design, there are two major classifications of auction: direct and indirect auctions. *Indirect auction* – like the sealed-bid auctions (e.g. Vickrey (1961) and Myerson (1981)), all-pay auction (e.g. Baye, Kovenock and de Vries (1993)), buyout auction (e.g. Kirkegaard and Overgaard (2008)) – is an auction which asks bidders to submit bids (their offered prices or willingness to pay). It is an auction that we have got most used to since it is more practical than others. A *direct auction* is an auction which asks each bidder's *type* (type itself is not the willingness to pay but it determines the willingness to pay). The direct auction is mostly applied when the study wants to characterize the optimal (revenue-maximizing) mechanism. For instance, Myerson (1981) applied the direct auction. Since asking about bidders' types is abstract, unlike asking about their willingness to pay, the direct auction is less practical when compared to an indirect auction.

5. *Revenue-enhancing rules.* Studies which aimed to find revenue-maximizing auctions introduced additional revenue-enhancing rules to their auctions. *Reservation-price rule* and *entry-fee rule* are the most common (e.g. Jehiel and Moldovanu (2000)). The reservation-price rule lets the seller set the lowest price which only bids higher than the reservation price being competitive for the object. The entry-fee rule lets the seller collect a fixed payment from bidders who want to submit bids. For instance, an English auction with an initial lowest price is imposed with a reservation-price rule. The lowest unique bid auction is normally imposed with the entry-fee rule; hence, the main source of revenue comes from collecting the fee, not from the bid. Besides common revenue-enhancing rules, other uncommon rules have been introduced. For instance, a *buy-out option* was an uncommon rule that has more recently gained in popularity.

6. *Others*. Some studies introduced other concerns in their models. For instance, Gupta and Lebrun (1999) allowed for resale.

5.2. Types of Externalities in Auctions

This section briefly reviews the types of externalities modeled in the recent literature on auction design. First, let us consider two different illustrations: one presenting negative externalities and the other positive externalities.

- *Cost-Reduction Technology*. Competitive firms compete for a new cost reduction technology. Only one firm can obtain it. The firm which obtains the technology will take more market share; while the others will lose it (Jehiel and Moldovanu, 2000). This illustration shows the negative externalities from the obtainer to other non-obtainers.

- *Airport*. Adjacent towns compete for a new airport. They bear no costs concerning the airport, only the bidding price that the towns must pay in this competition. The town which obtains the airport will have an economic boom; while the others have spillover effects from the boom. This illustration shows the positive externalities from the obtainers to other non-obtainers.

As discussed in the previous illustrations, by how are the payoffs of the bidders who do not obtain the object (the non-obtainers) we classify the external effects to: *negative* (when the payoffs are negative) and *positive* (when the payoffs are positive). Table 5.2-1 presents the payoffs of bidders i and j in each corresponding ex-post outcome – i obtains the object, j obtains, or nobody obtains. It presents two cases: when the auctioned object has negative externalities and when it has positive externalities.

From the table, in the case of the negative-externalities object, the obtainer gets positive payoffs (= 10) but the non-obtainer gets negative payoffs (= -10). In the case of the positive-externalities object, while the obtainer still gets positive payoffs (= 10), the non-obtainer also gets positive payoffs (= 5). Also, in either case if no bidder obtains the object, both players get zero payoff as status quo.

The external effects can be *constant* (like in Jehiel et al. (1996)). Graphically, Figure 5.2-1 presents the utility function for an object with constant externalities. On the left are the constant negative externalities; hence, the utility of bidder i is constantly negative if j obtains the object. On the right are the constant positive externalities; hence, the utility of bidder $i$is constantly positive if j obtains the object.

However, the case of constant externalities is not likely to occur in reality. For instance, when compared to a small shared-profit firm a big shared-profit firm not only gets higher profit from being the obtainer but also puts more negative externalities on the non-obtainers.

Table 5.2-1 Illustration of Negative and Positive Externalities.

	Negative externality		Positive externality	
Ex-post outcome	Payoffs of player i	Payoffs of player j	Payoffs of player i	Payoffs of player j
i obtains	10	-10	10	5
j obtains	-10	10	5	10
no bidder obtains	0	0	0	0

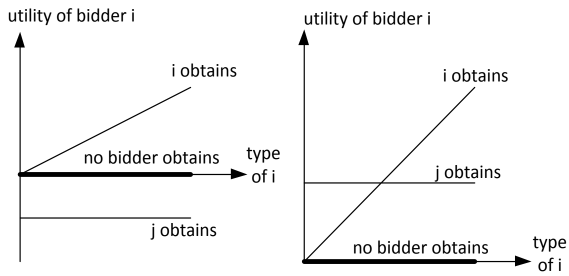

Figure 5.2-1 Utility function for an Object with Constant Externalities.

Table 5.2-2 Illustration of Identity-Dependent Negative Externalities.

Ex-post outcome	Payoffs of player i
i obtains	10
j obtains	-10
k obtains	-5
no bidder obtains	0

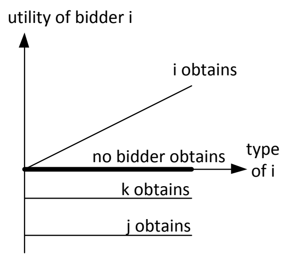

Figure 5.2-2 Utility function for an Object with Identity-Dependent Negative Externalities.

Hence, later studies modeled the external effects to be inconstant depending on the types of both obtainers and non-obtainers (which is called *type-dependent* externalities) or on the identity of the obtainer (which is called *identity-dependent* externalities). More precisely, like in Jehiel et al. (1996), the case of identity-dependent externalities is determined by who is the obtainer. For instance, Table 5.2-2 numerically presents the payoffs of bidder *i* in each ex-post outcome. In this auction, there are bidders *i, j* and *k*. The identity of the obtainer causes different negative effects to bidder *i*. Also, Figure 5.2-2 draws the utility function for an object with identity-dependent (and constant) negative externalities. The negative effects depend on the identity of obtainer. Obtainer *j* causes more negative effects than obtainer *k*.

Regarding type-dependent externalities, the external effect is determined by the bidders' types (like in Jehiel and Moldovanu (2000)). Table 5.2-3 presents the payoffs of bidder *i* in each ex-post outcome and his type. In this auction, each bidder may have a low or high type. If *j* obtains the object, the negative effects depend on bidder *i*'s type and bidder *j*'s type. For instance, if player *i* has a low type and player *j* obtains the object, player *i* gets -10 payoffs if player *j* has a low type or gets -20 payoffs if the player *j* has a high type – the effects depend on his opponent's type. Also, if player *j* obtains the object and has a low type, player *i* gets -10 payoffs if he has low type or gets -5 payoffs if he has high type – the effects depend on his type. Figure 5.2-3 presents the utility function for an object with type-dependent negative externalities. Obtainer *j* causes negative effects according to his type and non-obtainer *i*'s type.

This study, like in Chen and Potipiti (2010), focuses on the *decreasing-type-dependent positive externalities* called "*countervailing*" positive externalities (see Figure 5.2-4). The countervailing-positive-externalities case is more interesting than others since, technically, i) the case "generates countervailing incentives for types in the reporting stage of the mechanism." According to Chen and Potipiti (2010), "optimal mechanisms... typically feature bunching even... to serve the following purposes: First, bunching arises in a set of intermediate types... so as to address the conflict between individual rationality constraint and minimization of information rents; Second... bunching also arises in regions where virtual surplus in non-increasing so as to relax the incentive constraints of the buyers. Consequently, in the optimal mechanism, the type with zero payoffs is typically an *interior* type and each buyer's payoff is in general non-monotonic in types." ii) Since the type with zero payoffs (or *binding type*) is interior, finding the type is another difficulty in the characterization of the optimal auction.

Before we end this section, let us consider some illustrations which present the countervailing-positive externalities:

- *WTO Retaliation Rights*. Chen and Potipiti (2010) provided an application for the case of selling retaliation rights in the WTO. In this situation, there is one exporting country who exports to other importing countries. The exporting country violates the WTO agreement regarding another country. The violated country has the right to retaliate to the exporting country. However, the violated country does not want to implement the retaliation by itself, but wants to sell the rights to the importing countries; hence, the violated country is the seller and the importing countries are potential buyers. The obtainer will implement the retaliation which makes the world price of the exporting-importing good decrease. The non-obtainers also indirectly benefit from this price reduction. However, when the non-obtainers' government is concerned about the welfare distribution between consumers and producers, which is captured by a political parameter as the relative weight between consumer and producer surplus; the indirect benefits are less when the government weigh more to the producer side.

- *Airport*. This can be another good example of the countervailing-positive-externalities object. Think of two adjacent towns – A and B – competing for a new airport to be built in one town. The government has a budget to build one airport in town A or B. The

Table 5.2-3 Illustration of Type-Dependent Negative Externalities.

Ex-post outcome	Payoffs of player i with low type	Payoffs of player i with high type
i obtains	10	15
j with low type obtains	-10	-5
j with high type obtains	-20	-15
no bidder obtains	0	0

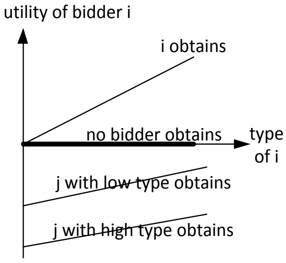

Figure 5.2-3 Utility Function for an Object with Type-Dependent Negative Externalities.

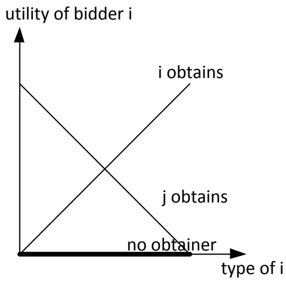

Figure 5.2-4 Utility Function for an Object with Countervailing-Positive Externalities.

town bears no cost of building the airport but does bear the maintenance costs of tourist attractions. Each town has its own number of tourist attractions which is exogenously given by nature (e.g. by geography of the town). The number of attractions represents the town's type. In the airport town (the town which obtains the airport), there will be economic boom with the more attractions the more profit (or payoffs) being gained (since the average revenue per attraction is higher than the average maintenance cost) – the obtainer has increasing payoffs in its type. In the non-airport town, since it is close to the airport town it will get substantial revenue from the spillover effects of the economic boom. In other words, for any type of non-airport town, the town always gets positive profit. Suppose that the economic boom provides fixed lump-sum revenue for the non-airport town. The non-airport town gets the highest profit when it has no attractions. Given that the average maintenance cost is constant in the number of attractions, since the average revenue is decreasing in number, the profit is decreasing as well. Therefore, in this example the airport shows the countervailing-positive-externalities property.[24]

5.3. Literature Review of Auction Design for an Object with Externalities

As already mentioned, this study is interested in designing an optimal auction for an object with countervailing-positive externalities; since this case is more interesting than other cases as discussed in the previous section. This section reviews the recent literature on auction design for an object with externalities. Jehiel, Moldovanu and Stacchetti (1996), Jehiel and Moldovanu (2000), Bagwell, Mavroidis and Staiger (2007), Brocas (2007) and Chen and Potipiti (2010) are all of interest here. Moreover, the work of Lewis and Sappington (1989) is also related since this study deals with *countervailing*-positive externalities and countervailing incentives.

Jehiel et al. (1996), Jehiel and Moldovanu (2000) and Brocas (2007) studied various cases of negative externalities – a non-obtainer gets negative payoffs from the negative-effect consumption of the obtainer. Jehiel et al. (1996) and Brocas (2007) both sought the revenue-maximizing auction. In their optimal auctions, they provided two interesting discussions. First, the optimal auction should have *rules* that pose threats to nonparticipating bidders to get the lowest possible payoffs; as a consequence, all potential bidders will participate in the auction and the seller will get a higher expected revenue. In the case of negative externalities, the rule is to promise selling the object to some participating bidders; hence, a nonparticipating bidder will always get negative payoff. Even in the case of a normal object – without externalities – where the revenue-maximizing mechanism as shown in Myerson (1981) is the second-price sealed bid auction with reservation price, the same rule that some participating bidders always obtain the object applies; hence, nonparticipating bidders always get the lowest possible payoff at zero payoff as status quo.

Second, in the case of negative externalities, the studies found that the seller can *extract non-obtainers' surplus*; in other words, in the optimal auction the non-obtainers pay some of the amount. That is, since the non-obtainers have incentives to pay to prevent selling the object being sold, the seller can extract surplus (from payment) from them. For instance, if a bidder gets -6$ when being a non-obtainer and gets 0 payoff when nobody is the obtainer, he is willing to pay up to 6$ to convince the seller to keep the object.

According to the Jehiel and Moldovanu (2000),in collecting payment from any non-obtainer the rule is *not credible*. Hence, the study studied a standard auction with only a

[24] We may mathematically express this as $C(t) = ct$ (where C is the total cost, c is the average variable cost per unit of attractions and t is type, or the number of attractions), $R_A(t; P) = A + Pt$ (where R_A is the total revenue of the airport town, A is the fixed revenue and P is the average revenue per unit of attractions such that $P > c$) and $R_{NA} = B$ (where R_{NA} is the total revenue of the non-airport town and B is the lump-sum revenue from economic boom).

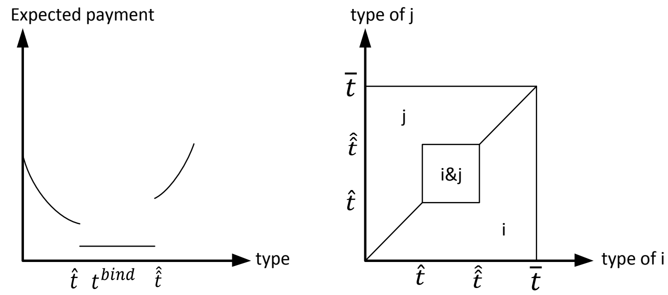

Figure 5.2-1 Expected Payment and Allocation of the Optimal Mechanism. (i = i obtains, j = j obtains, i&j = each bidder has 0.5 chance of being obtainer).

reservation price and entry fee as its credible rules. However, the standard auction is not an optimal auction.

Jehiel and Moldovanu (2000), Bagwell et al. (2007) and Chen and Potipiti (2010) addressed the case of positive externalities. Jehiel and Moldovanu (2000) studied second-price sealed bid auction and Bagwell et al. (2007) studied first-price sealed bid auction. They found the same problem – the *free-rider problem* – occurred in the case of positive externalities. This results in the seller getting less than expected revenue since some low-type bidders avoid participating. There has been no study that has solved this problem.

Chen and Potipiti (2010) studied the optimal auction in the case of countervailing-positive externalities under the direct-mechanism setting. It found the following points of interest:

i) The optimal mechanism selects the *binding type* – the type which gets zero utility (as status quo) from the mechanism. Unlike the case of the normal object where the binding type is the lowest type, the binding type in the study is in between the lowest and highest types (or *interiortype*). Figure 5.3-1 draws the expected payment (on the left) and allocation (on the right) of the optimal mechanism in Chen and Potipiti (2010). On the left, the x-axis is a bidder's type and the y-axis is the expected payment. The type is the interval $[\underline{t},\bar{t}]$ of which $\hat{t},\hat{\hat{t}},t^{bind}$ are its elements. On the right, the x-axis is bidder *i*'s type and y-axis is bidder *j*'s type; i = i obtains, j = j obtains, i&j = each bidder has 0.5 chance of being the obtainer. In the figure, the binding type is t^{bind} which is interior.

ii) Some types *around* the binding type are bunched (or *pooled*) together with the binding type. As presented in the figure, $(\hat{t},\hat{\hat{t}})$ is the *pooling region*. Hence, a bidder with any type in the region has the same expected payment. Also, in the case of the two bidders studied in the study, if both bidders have types in the region, each bidder has 0.5 chance of being the obtainer; this is the consequence of pooling characteristics.

iii) The optimal mechanism provides *countervailing incentives*.[25] As a consequence, as presented in the figure, the expected payment is *non-monotonic* in type.

[25] Lewis and Sappington (1989) provided the following definition: "countervailing incentives exist when the agent has an incentive to understate his private information for some of its

iv) In the optimal mechanism, if payoffs of bidders are high enough, all types have some expected payment and there is no chance of not selling (see Figure 5.3-1 on the right). The results imply that bidders *always participate* in the auction.

Moreover, like Chen and Potipiti (2010), Brocas (2007) also showed in the case of negative externalities that under some circumstances the optimal auction provided countervailing incentives by selecting the interior binding type and pooling its neighbors. Lewis and Sappington (1989), who studied the principal-agent problem with existence of externalities, found similar results.

Even though Chen and Potipiti (2010) successfully characterized the optimal auction for an object with countervailing-positive externalities, since the study was conducted under the direct-mechanism setting, the study did not show that what the *practically implementable* auction should be. Hence, this study aims to extend from that study by proposing a practically implementable auction for an object with countervailing-positive externalities.

To propose a practically implementable auction, a designer designs auction rules (including submitting bid mechanism, allocation, payment and other relevant rules). Typically, a designer may want an auction that creates either *efficient allocation* or *maximizing expected revenue*. For instance, a designer (e.g. government) who wants to design an auction with efficient allocation focuses on designing an auction in which the highest-type bidder (who gets the highest utility from being the obtainer) always obtains the object with there being no chance of not selling.[26] Also, a designer (e.g. private firm) who wants to design an auction with maximizing expected revenue (or the revenue-maximizing auction) focuses on designing an auction that maximizes *ex-ante* expected revenue.

However, it is quite common that, in most cases, *trade-off* between efficient allocation and maximizing expected revenue is necessary since both objectives cannot be accomplished at the same time.[27] As in the case of a normal object (without externalities), the second-price sealed-bid auction is the efficient auction but the auction with reservation price is the revenue-maximizing auction (Myerson, 1981). In the auction with reservation price, some bidders of low type avoid participating; hence, this increases the chance of not selling and it is an inefficient auction.

Hence, to design a revenue-maximizing auction, an efficient auction can be developed by adding some *revenue-enhancing rules.* Like in the case of a normal object, the reservation-price rule is added to the second-price sealed-bid auction.

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realizations, and to overstate it for others." As a consequence, "the agent's rents generally increase with the realization of his private information over some ranges, and decrease over other ranges."

[26] Further assumptions are needed: i) a bidder's utility of being the obtainer when having the lowest type is higher than the seller's utility of keeping the object and ii) the bidder's utility of being the obtainer is increasing in his type. Since, in a common model, the object gives no utility to the seller and the utility of being the obtainer is always positive, hence, the efficient allocation is carried out when the highest-type bidder always obtains and there is no chance of not selling.

[27] It is similar to that discussed in *The Myerson-Satterthwaite Theorem.*

The most common revenue-enhancing rules are the *reservation-price rule* and *entry-fee rule.* As discussed in Jehiel and Moldovanu (2000), there are basic revenue-enhancing rules in any auction which are credible and practical for implementation. However, to optimally maximize expected revenue, Jehiel et al. (1996) asserted that some proper revenue-enhancing rules (termed "*threats*" in the study) are necessary. In other words, only reservation-price and entry-fee rules may not be sufficient. This was further supported by Brocas (2007). The optimal rules, more precisely, will "*leave a nonparticipating buyer with the lowest possible level of utility*," according to Jehiel et al. (1996).

For instance, in the case of a normal object, the lowest possible level of utility happens when a bidder is a non-obtainer (and gets zero payoff as status quo). In the second-price sealed-bid auction with reservation price, the reservation-price rule commits that the seller always sells the object to some participating bidders. Hence, the rule always leaves zero payoff to any nonparticipating bidder and the auction with the rule is the revenue-maximizing auction.

Similarly, in the case of a negative-externalities object, the lowest utility occurs when a bidder suffers from the negative effects. In other words, he suffers most from being a non-obtainer. Like in Jehiel et al. (1996) and Brocas (2007), the revenue-maximizing auction commits that the seller always allocates the object to some participating bidder and leaves the negative effects to any nonparticipating bidder.

In the case of the positive-externalities object, a bidder suffers most from a no sell outcome in the event. The optimal rule is most likely to commit no sale at all if somebody avoids participating, otherwise referred to as "*no sale condition*." However, there has been no study applying the no sale condition with an auction for an object with positive externalities. Hence, it has just been conjecture.

In the case of externalities, as discussed in Brocas (2007), the *entry-fee rule* is important in the revenue-maximizing auction. In the case of the normal object, the reservation-price and entry-fee rules are equivalent and can result in a revenue-maximizing auction.[28] However, in the case of externalities, both rules seem to be not equivalent.[29]

A rule which provides countervailing incentives in the auction (or the *countervailing-incentive rule*) seems to be necessary, under some circumstances, for the revenue-maximizing auction for an object with externalities since some literature has found that their optimal mechanisms provided countervailing incentives (Lewis and Sappington, 1989; Brocas, 2007; Chen and Potipiti, 2010).

Lastly, as commonly observed in previous literature related to the countervailing-incentive mechanism, the optimal mechanism has a set of interior types which are pooled together with the binding type – or *pooling types* (Lewis and Sappington, 1989; Brocas, 2007; Chen and Potipiti, 2010). It is considered another important property of the optimal

[28] The equivalence directly comes from the *revenue equivalence theorem.*

[29] Jehiel and Moldovanu (2000) showed that the reservation-price rule affected the equilibrium bidding strategy while the entry-fee rule did not.

mechanism. In this study, we refer to it as the "*pooling rule.*" The rule has one important revenue-enhancing effect – it can reduce the information rent, which means it increases the revenue. Lewis and Sappington (1989) and Brocas (2007) further discussed the second effect.

CHAPTER VI
EFFICIENT AUCTION FOR AN OBJECT WITH COUNTERVAILING-POSITIVE EXTERNALITIES

As presented by Jehiel and Moldovanu (2000) and Bagwell et al. (2007), when the object has positive externalities the basic auction – which lets the highest-bid bidder obtain the object and pay – the price fails to be optimal (neither for efficient allocation nor maximizing revenue).

In this chapter, we present the failure of the second-price sealed-bid auction, which is one of the most common basic auctions, when applied with the (countervailing-) positive externalities object. Regarding the equilibrium strategy in the auction, we can see that the second-price sealed-bid auction fails to allocate the object efficiently when some bidders are low types.

Therefore, it is the main objective of this chapter to propose a new auction which allocates the object efficiently. We propose the new auction called "*take-or-give with second-price payment*." As concerns the equilibrium strategy in the new auction, it shows that the new auction allocates the object efficiently.

We present this chapter in four sections. In section 6.1., we present the model. In section 6.2., we analyze the equilibrium strategy of bidders in the second-price sealed-bid auction to see how the auction fails to be optimal. In section 6.3., we analyze the equilibrium strategy of bidders in the new proposed auction, take-or-give auction with second-price payment, and show that it allocates the object efficiently. The last section provides the conclusion.

6.1. Model

This study follows the same model as that analyzed in Chen and Potipiti (2010) for the case of the countervailing-positive-externalities object. There are two risk neutral and symmetric bidders. They compete in an auction for an indivisible object with countervailing positive externalities. The object has no value for the seller.

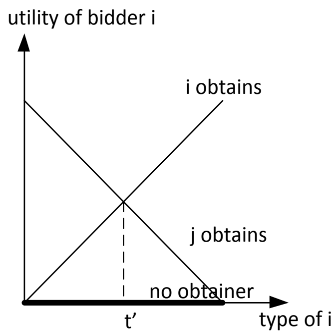

Figure 6.1-1 Bidder's Utility Function for Countervailing-Positive Externalities.

In our analysis, we denote $i, j \in N = \{1,2\}$ and $i \neq j$ as the index of bidders. For any bidder i, his type t_i is randomly drawn from the type space $T = [\underline{t}, \bar{t}]$ with distribution function F and its associated density function f which $f(t) > 0$ for all $t \in T$.

As presented in Figure 6.1-1, for the case of countervailing-positive externalities, the bidder *i*'s utility is defined as increasing in his type if he obtains the object but decreasing in his type if his opponent (bidder *j*) obtains the object; and bidder *i* gets zero utility if the seller keeps the object, or there is no obtainer, as status quo. Also, the opponent (bidder *j*) 's type does not affect bidder *i*'s utility.

To be precise, if a bidder *i* with type $t_i \in T$ obtains the object, he gets utility $W_i(t_i) \geq 0$. In the model, we assume that the rate of change of his utility with respect to his type is constant a which increases in his type ($\frac{dW_i(t_i)}{dt_i} = a_i > 0$), but it does not depend on his opponent (bidder *j*) 's type ($\frac{dW_i(t_i)}{dt_j} = 0$); so the bidder *i*'s utility function, $W_i(t_i)$, is linear in his type t_i as presented in Figure 6.1-1. Hence, if the bidder *i* with type t_i obtains the object, he gets utility $W(t_i)$ as,

$$W_i(t_i) = A_i + a_i t_i \qquad (6.1-1)$$

for all $i \in N$ where A_i is the fixed-effect positive utility and $A_i \geq a_i \underline{t}$ to satisfy $W_i(t_i) \geq 0$ for any type.

Similarly, if the bidder *i* does not obtain the object but his opponent obtains it, the bidder *i* gets positive utility from the positive externalities. Let $L_i(t_i) \geq 0$ be the bidder *i*'s utility when his opponent obtains the object. As for countervailing-positive externalities, the rate of change of the bidder *i*'s utility when his opponent obtains the object decreases in his own type ($\frac{dL_i(t_i)}{dt_i} < 0$) but does not depend on his opponent's type ($\frac{dL_i(t_i)}{dt_j} = 0$). For simplicity, we assume the rate of change to be constant; so we get the utility function $L_i(t_i)$ to be linear in t_i as presented in Figure 6.1-1. Hence, if the bidder *j* with any type obtains the object, the bidder *i* with type t_i gets utility as,

$$L_i(t_i) = B_i - b_i t_i \qquad (6.1-2)$$

for all $i \in N$ where $b_i > 0$ is the constant rate of change of utility in this case; B_i is the fixed-effect positive utility. To satisfy that $L_i(t_i) \geq 0$ for any type t_i, we assume that $B_i \geq b_i\bar{t}$.

Moreover, it is interesting that there is a type which the bidder i feels indifference between toward between being the obtainer by himself or letting his opponent obtain the object. More precisely, in the model, we assume that there is the type $t' \in T$ such that $W_i(t') = L_i(t')$, as presented in Figure 6.1-1. To satisfy the case, we assume $\underline{t} \leq \frac{B_i - A_i}{a_i + b_i} \leq \bar{t}$.

In our study, we are interested in the case of two symmetric bidders. To be more precise, the bidders are symmetrical when $W_i(t) = W_j(t)$ and $L_i(t) = L_j(t)$ for any type t. In other words, from (6.1-1), $a_i = a_j = a$ and $A_i = A_j = A$; and, from (6.1-2), similarly $b_i = b_j = b$ and $B_i = B_j = B$. To simplify the notations, we write (6.1-1) as $W(t) = A + at$ and (6.1-2) as $L(t) = B - bt$.

In summary, equation (6.1-3) shows the model and its assumptions are noted in Assumption 6.1-1.

$$u_i(t_i) = \begin{cases} W(t_i) = A + at_i \; if \; bidder \; i \; obtains \\ L(t_i) = B - bt_i \; if \; bidder \; j \; obtains \\ \quad 0 \; if \; no \; obtainer \end{cases} ; for \; \forall i \in N \qquad (6.1-3)$$

ASSUMPTION 6.1-1: $A \geq a\underline{t}$, $B \geq b\bar{t}$, $a > 0$, $b > 0$ *and* $\underline{t} \leq \frac{B-A}{a+b} \leq \bar{t}$.

6.2. Second-Price Sealed-Bid Auction for an Object with Countervailing-Positive Externalities

This section aims to characterize the symmetric-equilibrium strategy in the second-price sealed bid auction for an object with countervailing-positive externalities. It starts with a simple illustration applying the setting of two discrete types and perfect information. Then, in sub-section 6.2.2., the continuous case as specified in our model is applied (in section 6.1.).

6.2.1. Simple Illustration with Discrete Case and Perfect Information

The aim here is to characterize the symmetric-equilibrium strategy in the second-price sealed-bid auction for an object with countervailing-positive externalities by applying a simple illustration with discrete case and perfect information. The equilibrium strategy is presented in Proposition 6.2-1. Consequently, we can see how the auction failure happens.

Table 6.2-1 Illustration of the Payoffs of Two Discrete Types.

Type	Payoffs when being the obtainer W	Payoffs when being the non-obtainer L	No obtainer
High type t_h	$W(t_h)$	$L(t_h)$	0
Low type t_l	$W(t_l)$	$L(t_l)$	0

In this simple case, there are two identical bidders (i and j) and their types can be either high type t_h or low type t_l. For a high-type bidder, he gets $W(t_h)$ payoff if he is the obtainer and $L(t_h)$ payoff if the non-obtainer (which means that his opponent obtains the object). Similarly, for a low-type bidder, he gets $W(t_l)$ and $L(t_l)$ payoff if the obtainer or non-obtainer respectively. Also, if there is no obtainer, each bidder gets zero utility as status quo. Table 6.2-1 presents the payoffs of this discrete case.

We assume that $0 \leq W(t_l) < W(t_h)$ and $0 \leq L(t_h) < L(t_l)$ to capture the countervailing-positive externalities. (Recall Figure 6.1-1 for more in-depth understanding). We also assume that the high type is the part in which utility from being the obtainer is higher than from being the non-obtainer, $W(t_h) > L(t_h)$. Additionally, the low type is the part in which utility from being the non-obtainer is higher than from being the obtainer, $W(t_l) < L(t_l)$. The assumptions are summed up below in Assumption 6.2-1.

ASSUMPTION 6.2-1: $0 \leq W(t_l) < W(t_h)$, $0 \leq L(t_h) < L(t_l)$, $W(t_h) > L(t_h)$ *and* $W(t_l) < L(t_l)$.

In the situation, the bidders compete for an object (with countervailing-positive externalities) in the second-price sealed-bid auction. The second-price sealed-bid auction is processed in the following four steps:

1. Participation: Each bidder decides whether to participate in the auction or not.
2. Bid submission: A participating bidder submits a positive bid. A nonparticipating bidder does not submit a bid.
3. Allocation: The seller allocates the object to the highest-bid bidder. If there is no bid (since there are no participating bidders), the seller keeps the object.
4. Payment: The highest-bid bidder who obtains the object pays,
    - equal to his opponent's bid, or
    - there is no payment if his opponent does not participate.

For simplicity, consider the case in which both bidders are identical. A bidder i with type t_i and a bidder j with type t_j are identical when $t_i = t_j = t$. This assumption makes our illustration a lot simpler but without loss of any important information.

We scope our interests in characterizing the symmetric-equilibrium strategy which means that, in equilibrium, both players apply the identical strategy. According to the auction process, let a bidder i's strategy be (ρ_i, b_i) which $\rho_i \in \{P, N\}$ means that he participates $(\rho_i = P)$ or does not participate $(\rho_i = N)$ in the auction and $b_i \geq 0$ is his bid. Note that not participating and participating with zero bid are different; a bidder who participates with zero bid has some chance of obtaining the object, whereas a nonparticipating bidder has no chance.

The symmetric-equilibrium strategy in the second-price sealed-bid auction (ρ^S, b^S) is presented in Proposition 6.2-1.

PROPOSITION 6.2-1: *In the case of two discrete types and perfect information with two identical bidders, symmetric-equilibrium strategy in second-price sealed-bid auction is that a high-type bidder participates with $W(t_h) - L(t_h)$ bid, while a low-type bidder participates with $\frac{2W(t_l)}{W(t_l)+L(t_l)}$ chance and bids zero.*

$$\rho^S(t) = \begin{cases} P\ for\ t_h \\ \dfrac{2W(t_l)}{W(t_l)+L(t_l)}P + \dfrac{L(t_l)-W(t_l)}{W(t_l)+L(t_l)}N\ for\ t_l \end{cases}, b^S(t) = \begin{cases} W(t_h) - L(t_h)\ for\ t_h \\ 0\ for\ t_l \end{cases}.$$

Proof: *See Appendix B.1.*

In the equilibrium strategy, a high-type bidder always participates and submits a bid that equates to his willingness to pay. The willingness to pay is the difference between the first and second best alternatives – being the obtainer that yields utility $W(t_h)$ and being the non-obtainer that yields utility $L(t_h)$; hence, the difference is $W(t_h) - L(t_h)$. In the case of the low type, in equilibrium a bidder with low type randomly participates in the auction with $\frac{2W(t_l)}{W(t_l)+L(t_l)}$ chance and, if he participates, always submits the lowest possible bid, which is zero.

If we consider the auction's efficiency of allocation (the auction is efficient when the highest-type bidder always obtains the object), the second-price sealed-bid auction is efficient when applied to a high-type case, but is not efficient when applied to a low-type case. To be more specific, in the case of the low type, there is some chance (which is $\left[\frac{L(t_l)-W(t_l)}{W(t_l)+L(t_l)}\right]^2$) that there is no obtainer and the seller keeps the object. The result implies auction failure, especially in the allocation aspect.

As regards the revenue aspect, the auction also fails to maximize the seller's expected revenue. In the case of perfect information, it is easy to check whether an auction maximizes the seller's expected revenue or not by checking each bidder's expected surplus left from playing the equilibrium strategy in the auction. That is, an auction maximizes the seller's expected revenue when each bidder is left with zero surplus.

According to the equilibrium strategy, the expected surplus in the second-price sealed-bid auction is not zero (as presented in Table 6.2-2). To derive it, according to the equilibrium strategy, a high-type bidder has $\frac{1}{2}$ chance of being the obtainer and gets $W(t_h) - \big(W(t_h) - L(t_h)\big)$ surplus; and he has the other $\frac{1}{2}$ chance of being the non-obtainer and gets $L(t_h)$ surplus. Hence, a high-type bidder has $\frac{1}{2}\Big(W(t_h) + L(t_h) - \big(W(t_h) - L(t_h)\big)\Big) = L(t_h)$

as expected surplus. Similarly, a low-type bidder has $\left(\frac{2W(t_l)}{W(t_l)+L(t_l)}\right)^2$ chance when he and his opponent participate, $\left(\frac{2W(t_l)}{W(t_l)+L(t_l)}\right)\left(\frac{L(t_l)-W(t_l)}{W(t_l)+L(t_l)}\right)$ chance when there is only one participant and $\left(\frac{L(t_l)-W(t_l)}{W(t_l)+L(t_l)}\right)^2$ when there are no participants. If both participate, he has $\frac{1}{2}$ chance of being the obtainer and non-obtainer equally; if he participates but his opponent does not, he is the obtainer and gets $W(t_l)$ payoff; if his opponent participates but he does not, he is the non-obtainer and gets $L(t_l)$ payoff; if there is no participant, the seller keeps the object. Hence, a low-type bidder gets $\left(\frac{2W(t_l)}{W(t_l)+L(t_l)}\right)^2 \frac{1}{2}\left(W(t_l) + L(t_l)\right) + \left(\frac{2W(t_l)}{W(t_l)+L(t_l)}\right)\left(\frac{L(t_l)-W(t_l)}{W(t_l)+L(t_l)}\right)\left(W(t_l) + L(t_l)\right) + \left(\frac{L(t_l)-W(t_l)}{W(t_l)+L(t_l)}\right)^2 0 = \left(\frac{2W(t_l)}{W(t_l)+L(t_l)}\right)$ as expected surplus.

Also notice that, even if the auction induces a bidder of a high type to submit a bid reflecting his willingness to pay, it cannot extract all of his surplus. As presented in the table, a high-type bidder is left $L(t_h)$ surplus from the externalities. Hence, this implies that in the revenue-maximizing auction some revenue-enhancing rules should be additionally implemented to extract the surplus (in Chapter VII some auctions which can increase the expected revenue are presented).

6.2.2. Continuous Case and Imperfect Information

To complete showing the symmetric-equilibrium strategy in the second-price sealed-bid auction, this section applies the continuous case and imperfect information as presented in the model (6.1-3). In the model, there are two risk-neutral and symmetric bidders whose types are independently and randomly drawn from $[\underline{t}, \bar{t}]$. The type has distribution function F and its associated density function f.

In the second-price sealed-bid auction, the symmetric-equilibrium strategy (ρ^S, b^S) is presented in Proposition 6.2-2.

PROPOSITION 6.2-2: *In the continuous case with imperfect information, the symmetric-equilibrium strategy in a second-price sealed-bid auction is that a bidder with type $t \in [\underline{t}, \tilde{t})$ does not participate. A bidder with type $t \in [\tilde{t}, t')$ participates with zero bid. A bidder with type $t \in [t', \bar{t}]$ participates with $W(t) - L(t)$ bid.*

$$\rho^S(t) = \begin{cases} N \; for \; t \in [\underline{t}, \tilde{t}) \\ P \; for \; t \in [\tilde{t}, \bar{t}] \end{cases}, b^S(t) = \begin{cases} 0 \; for \; t \in [\underline{t}, t') \\ W(t) - L(t) \; for \; t \in [t', \bar{t}] \end{cases}$$

where $\tilde{t} < t'$ and $\tilde{t}$ solves

$$W(\tilde{t}) * F(\tilde{t}) + \frac{1}{2}\left(W(\tilde{t}) - L(\tilde{t})\right) * \left(F(t') - F(\tilde{t})\right) = 0. \qquad (6.2-1)$$

Proof: *See Appendix B.2.*

According to the proposition, Figure 6.2-1 presents the symmetric-equilibrium strategy (on the left) and allocation (on the right) in a second-price sealed-bid auction. On the

Table 6.2-2 Expected Surplus and Revenue in Second-Price Sealed-Bid Auction, Discrete Types and Perfect Information.

Type Realization		Second-Price Sealed-Bid Auction
High t_h	Surplus	$L(t_h)$
	Revenue	$W(t_h) - L(t_h)$
Low t_l	Surplus	$\dfrac{2W(t_l)}{W(t_l) + L(t_l)}$
	Revenue	0

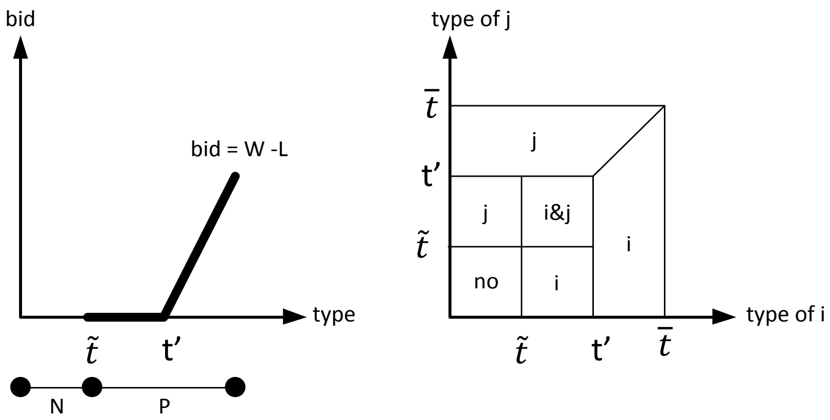

Figure 6.2-1 Symmetric-Equilibrium Strategy and Allocation in Second-Price Sealed-Bid Auction. (no = no obtainer, i = i obtains, j = j obtains, i&j = each bidder has 0.5 chance of being obtainer).

left, the y-axis is bid, the x-axis is type and the line under x-axis denotes participating (P) or not participating (N) for each corresponding type. On the right, x- and y-axes are types of both bidders (no = no obtainer, i = i obtains, j = j obtains, i&j = each bidder has 0.5 chance of being the obtainer).

In the allocation by the equilibrium strategy (Figure 6.2-1 on the right), we see that the auction fails to make an efficient allocation when some bidders have low types, which are the types t lower than type t' ($t \in [\underline{t}, t')$). Recall that type t' is the type in which a bidder feels indifference between being the obtainer and being the non-obtainer ($W(t') = L(t')$). Hence, the type $t \in [\underline{t}, t')$ is the type in which a bidder prefers being the non-obtainer to being the obtainer ($L(t) > W(t)$).

In the equilibrium strategy, for a bidder of low type, $t \in [\underline{t}, t')$, we can see that there are two groups of strategy: the first group is $t \in [\underline{t}, \tilde{t})$ in which the strategy is not participating and the second group is $t \in [\tilde{t}, t')$ in which the strategy is participating with zero bid. Intuitively, since a bidder with low type $t \in [\underline{t}, t')$ prefers being the non-obtainer to being the obtainer, he would like to maximize his opponent's chance of being the obtainer; hence the bidder is likely to avoid participating in the auction as observed in the first group $t \in [\underline{t}, \tilde{t})$. However, since it is possible that his opponent will not participate in the auction, the bidder should participate with the lowest possible bid, which is zero, to prevent an event where there is no sale as observed in the second group. The critical type $\tilde{t}$ is the type which a bidder with this type feels indifference between not participating and participating with zero bid.

Since the second-price sealed-bid auction does not provide proper incentives by setting the rules in which the highest-bid bidder pays the price and obtains the object, the auction cannot induce a low-type bidder, who does not want to obtain the object, to participate with willingness to pay. Therefore, the low-type bidder causes auction failure. This problem extends to any basic auction which has such rules, including first-price sealed-bid auction as presented in Bagwell et al. (2007).

The next section presents a new auction which provides proper incentives to the low-type bidder and fixes the aforementioned problem. This is called "*take-or-give auction with second-price payment.*"

6.3. Take-or-Give Auction with Second-Price Payment

In the previous section, we presented the symmetric-equilibrium strategy in the second-price sealed-bid auction for an object with countervailing-positive externalities. We also looked at the auction failure of a bidder with low type $t \in [\tilde{t}, t')$ since the auction does not provide proper incentives.

This section presents a new type of auction referred to as "*take-or-give with second-price payment.*" Differing from the basic auction, the new auction lets the highest-bid bidder *pay for his desired allocation*. He can select either to *take* the object or to *give* it away to his opponent.

This section begins with a simple illustration of the new auction by applying two discrete types and perfect information. The illustration presents the allocation and payment rules of the auction. Then, it characterizes the symmetric-equilibrium strategy (Proposition 6.3-1). In the equilibrium strategy, in the new auction all bidders participate with willingness to pay. Lastly, sub-section 6.3.2. completes the analysis by characterizing the symmetric-equilibrium strategy in the model of continuous types and imperfect information (Proposition 6.3-2). In the equilibrium strategy, it is also shown that the auction fixes the problem of low-type bidder and creates efficient allocation (Corollary 6.3-1).

6.3.1. Simple Illustration with Discrete Case and Perfect Information

Since any basic auction fails to be optimal since it does not provide appropriate incentives for bidders who have greater utility from being the non-obtainer than from being the obtainer, $L(t) > W(t)$, auction failure occurs. Hence, this study proposes a new auction which can fix the problem by providing appropriate incentives – *allowing the highest-bid bidder to select for himself his desired allocation*. In other words, instead of always obtaining the object, the new auction lets the highest-bid bidder choose whether to *take* the object and be the obtainer or to *give* the object to his opponent and be the non-obtainer. The new auction is the "*take-or-give auction with second-price payment*."

More precisely, the take-or-give auction with second-price payment proceeds according to the four following steps:

1. Participation: Each bidder decides whether to participate in the auction or not.
2. Demand and Bid Submission: A participating bidder submits a doublet of *demand* of allocation and *bid*. Demand can be *take* or *give*, while bid is any real number. A nonparticipating bidder neither submits a demand nor a bid.
3. Allocation: The seller allocates the object as the highest-bid bidder's demand. The obtainer could be,
    - the highest-bid bidder if he demands to *take*, or
    - his opponent if the highest-bid bidder demands to *give*, or
    - there is no obtainer if there is no participating bidder.
4. Payment: The highest-bid bidder pays,
    - equal to his opponent's bid when both bidders submit the same demand, or
    - there is no payment if they submits a different demand or his opponent does not participate.

The take-or-give auction allows each participating bidder to submit a doublet which comprises a *bid* and the *demand* of allocation of the object. The demand can be either to take and be the obtainer or to give his opponent the object (for free as a gift) and be a non-obtainer.

Allocation is done as the highest-bid bidder's demand; if he demands to take then he obtains the object; if he demands to give then he gives his opponent the object. Note that he gives it as *a gift*, gives it *for free*; the receiver pays nothing, obtains the object and voluntarily decides whether to consume or not. Also, notice that optimally the receiver voluntarily consumes the object and the giver gets positive externalities.[30]

The payment is the second-price payment conditioned on their demands. More precisely, if both bidders submit the *same demand*, the highest-bid bidder pays his opponent's bid as the second price. Or if both bidders submit *different demands*, they pay nothing (as a zero reservation price conditioned on each demand).

[30] The receiver voluntarily consumes the object since not consuming leaves him zero payoff while consuming yields him $W > 0$.

Table 6.3-1 Examples for Allocation and Payment Mechanisms in Take-or-Give Auction with Second-Price Payment.

Scenario	Strategies	Allocation	Payment
1	Both demand to take. Bidder *i* bids 10$. Bidder *j* bids 7$.	Bidder *i* obtains.	Bidder *i* pays 7$. Bidder *j* pays 0$.
2	Both demand to give. Bidder *i* bids 10$. Bidder *j* bids 7$.	Bidder *j* obtains.	Bidder *i* pays 7$. Bidder *j* pays 0$.
3	Bidder *i* bids 10$ and demands to take. Bidder *j* bids 7$ and demands to give.	Bidder *i* obtains.	Both pay nothing.
4	Bidder *i* bids 10$ and demand to give. Bidder *j* does not participate.	Bidder *j* obtains.	Both pay nothing.

Table 6.3-1 presents four scenarios as examples for allocation and payment mechanisms in take-or-give auction with second-price payment. In the 1st and 2nd scenario, if the highest-bid bidder submits the same demand as his opponent's, he pays the second price and allocates the object as his demand. In the 3rd and 4th scenarios, respectively, if the highest-bid bidder submits a different demand as his opponent's or his opponent does not participate, he allocates the object as his demand without payment.

Notice that, as presented in the fourth scenario in Table 6.3-1, in the take-or-give auction the seller can allocate the object to any nonparticipating bidders. This point is made in Assumption 6.3-1,

ASSUMPTION 6.3-1: *The seller can allocate the object to any nonparticipating bidder.*

This assumption is different from other basic auction assumptions, which implicitly state that the seller cannot allocate the object to any nonparticipating bidder. The assumption plays a crucial role in our following results.

Next, we apply the case of two discrete types and perfect information (as presented in Table 6.2-1) and analyze the symmetric-equilibrium strategy in the take-or-give auction with second-price payment. In the auction, bidder i has strategy (ρ_i, b_i, d_i) which $\rho_i \in \{P, N\}$ means that he participates ($\rho_i = P$) or does not participate ($\rho_i = N$) in the auction, $b_i \in \mathbb{R}$ is his bid and $d_i \in \{take, give\}$ is the demand to take ($d_i = take$) or demand to give ($d_i = give$). Under the setting of two discrete types (as presented in the table) and perfect information, in assuming identical bidders, each bidder is of an identical type: high type t_h or low type t_l. The symmetric-equilibrium strategy in the take-or-give auction with second-price payment $(\rho^{TG}, b^{TG}, d^{TG})$ is presented in Proposition 6.3-1.

PROPOSITION 6.3-1: *In the case of two discrete types and perfect information with two identical bidders, the symmetric-equilibrium strategy in a take-or-give auction with second-price payment is that all bidders always participate. A high-type bidder submits a demand to take and* $W(t_h) - L(t_h)$ *bid. A low-type bidder submits a demand to give and* $L(t_l) - W(t_l)$ *bid.*

$$\rho^{TG} = P \,, b^{TG} = \begin{cases} W(t_h) - L(t_h) \; for \; t_h \\ L(t_l) - W(t_l) \; for \; t_l \end{cases}, d^{TG}(t) = \begin{cases} take \; for \; t_h \\ give \; for \; t_l \end{cases}.$$

Proof: *See Appendix B.3.*

According to the equilibrium strategy, there is no problem with not participating nor participating with zero bid. Recall that in the second-price sealed-bid auction when a bidder has low type, we see this as causing auction failure. In the take-or-give auction, the problem is fixed since the auction provides appropriate incentives to bidders of any types. Moreover, there is no chance of not selling. Comparing this with the second-price sealed-bid auction in which there is some chance of not selling, the take-or-give auction is more efficient.

Besides the increase in efficiency, the take-or-give auction also increases the expected revenue. Table 6.3-2 presents the expected surplus and revenue from the auction compared with the second-price sealed-bid auction (as presented in Table 6.2-2). When compared with the second-price sealed-bid auction in which a low-type bidder does not participate or participates with zero bid (Proposition 6.2-1), the new auction can extract payment from a low-type bidder; hence, the expected surplus of a low-type bidder in the new auction $W(t_l)$ is less than from the sealed-bid auction $\frac{2W(t_l)}{W(t_l)+L(t_l)}$ and the expected revenue, $L(t_l) - W(t_l)$, is higher; in contrast, there is no difference in a high-type bidder's strategy. However, it is not a revenue-maximizing auction since the revenue-maximizing auction extracts all surplus in the perfect-information setting.

6.3.2. Continuous Case and Imperfect Information

As presented in the previous section, in the illustration of discrete types and perfect information, the take-or-give auction with second-price payment fixes the problem of non-participation or participating with zero bid. This section characterizes the symmetric-equilibrium strategy in the auction by applying the continuous case with imperfect information. The model is as presented in section 6.1. In the auction, the symmetric-equilibrium strategy $(\rho^{TG}, b^{TG}, d^{TG})$ is presented in Proposition 6.3-2.

PROPOSITION 6.3-2: *In a continuous case with imperfect information, the symmetric-equilibrium strategy in a take-or-give auction with second-price payment is that all bidders participate. A bidder of type* $t \in [\underline{t}, t')$ *submits a* $L(t) - W(t)$ *bid and demand to give. A bidder of type* $t \in [t', \bar{t}]$ *submits a* $W(t) - L(t)$ *bid and demand to take.*

$$\rho^{TG} = P \,, b^{TG}(t) = \begin{cases} W(t) - L(t) \; if \; t \in [t', \bar{t}] \\ L(t) - W(t) \; if \; t \in [\underline{t}, t') \end{cases}, d^{TG}(t) = \begin{cases} take \; if \; t \in [t', \bar{t}] \\ give \; if \; t \in [\underline{t}, t') \end{cases}.$$

Proof: *See Appendix B.4.*

According to the proposition, Figure 6.3-1 presents the symmetric-equilibrium strategy (on the left) and allocation (on the right) in the take-or-give auction with second-price payment. On the left, the y-axis is the bid, the x-axis is the type and the line under x-axis

Table 6.3-2 Expected Surplus and Revenue in Take-or-Give Auction with Second-Price Payment and Second-Price Sealed-Bid Auction in Discrete Types and Perfect Information.

Type Realization		Take-or-Give Auction	Second-Price Sealed-Bid Auction
High t_h	Surplus	$L(t_h)$	$L(t_h)$
	Revenue	$W(t_h) - L(t_h)$	$W(t_h) - L(t_h)$
Low t_l	Surplus	$W(t_l)$	$\frac{2W(t_l)}{W(t_l) + L(t_l)}$
	Revenue	$L(t_l) - W(t_l)$	0

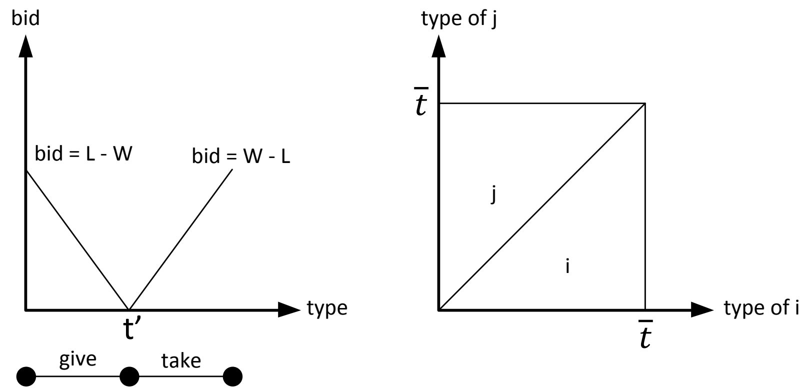

Figure 6.3-1 Symmetric-Equilibrium Strategy and Allocation in Take-or-Give Auction with Second-Price Payment. (i = i obtains, j = j obtains).

denotes the demand to take (take) or to give (give) for each corresponding type. On the right, x- and y-axes are the types of both bidders. (i = i obtains, j = j obtains).

The equilibrium strategy shows that all bidders participate with their willingness to pay ($L(t) - W(t)$ for $t \in [\underline{t}, t')$ and $W(t) - L(t)$ for $t \in [t', \bar{t}]$); recall that type t' is the type in which a bidder feels indifference between being the obtainer or being the non-obtainer, $W(t') = L(t')$. Hence, the problem of not participating and participating with zero bid is fixed. For the type t' in which a bidder participates with zero bid in the take-or-give auction, is no longer the problem we mentioned; recall that the problem of participating with zero bid occurs since a bidder wants to maximize his opponent's chance of being the obtainer and to prevent the event with no sale – this is not the case for the t'-type bidder in the take-or-give auction.

Moreover, the auction is efficient (Corollary 6.3-1) since there is no chance of not selling and the highest-type bidder always obtains the object (see Figure 6.3-1 on the right).

COROLLARY 6.3-1: *The take-or-give auction with second-price payment is the efficient auction for an object with countervailing-positive externalities.*

6.4. Conclusions

This chapter presented the auction failure of the second-price sealed-bid auction when applied with an object with countervailing-positive externalities. The main cause of the failure comes from a bidder of some low types who wants to maximize his opponent's chance of being the obtainer by not participating or participating with zero bid. As a consequence, the sealed-bid auction fails to be optimal for either efficient allocation or maximizing revenue.

Therefore, in this chapter, we propose a new auction called the "*take-or-give auction with second-price payment*" which can fix the problem of inefficient allocation of the second-price sealed-bid auction. Since the new auction lets each bidder compete for his desired allocation, the new auction provides appropriate incentives for bidders of any type; hence, there are no bidders intending to maximize the opponent's chance of being the obtainer like in the sealed-bid auction.

For a designer concerned with the efficiency of the allocation (e.g. government), the take-or-give auction is the best choice. However, it needs to be noted that the seller and bidders must commit to the rules of the new auction. As presented in Assumption 6.3-1, they must ensure that the auction can collect payments from non-obtainers and that it is possible to allocate the object to a nonparticipating bidder. To avoid the problem of commitments, the seller should announce the rules prior to making participation decisions on bidders, and all bidders should acknowledge them.

CHAPTER VII
TAKE-OR-GIVE AUCTION WITH ENTRY FEE

In the previous chapter, we saw that the take-or-give auction creates efficient allocation when applied to an object with countervailing-positive externalities (Corollary 6.3-1), while the second-price sealed-bid auction fails to allocate the object efficiently (see Section 6.2.). However, the take-or-give auction is not a revenue-maximizing auction.

Regarding the take-or-give auction not being a revenue-maximizing auction, recall the results from the discrete case with perfect information (see section 6.3.). Normally, with perfect information, at equilibrium a revenue-maximizing auction will extract all surplus from a bidder of any type. As we track a bidder's surplus left from playing the equilibrium strategy (see Table 6.3-2), either a high- or low-type bidder is left with some surplus.

In this chapter, we propose some extended take-or-give auctions which yield higher expected revenue than the simple take-or-give auction. To increase the revenue, we introduce revenue-enhancing rules to the auction. First, in section 7.1., we introduce only*entryfee*since the entry fee can directly extract surplus from externalities and it is mostly applied in the case of object with externalities. Second, in section 7.2., we introduce more complicated rules. These include entry fee with a no sale condition (in which the auction is cancelled if any potential bidder does not participate) and *indifference demand*(which allows bidders to participate with a new type of demand – indifference demand). Section 7.3.compares the expected revenue of each proposed auction and of the optimal auction in Chen and Potipiti (2010). Lastly, a conclusion is provided.

7.1. Take-or-Give Auction with Entry Fee

This section aims to characterize the symmetric-equilibrium strategy in the take-or-give auction with second-price payment and entryfee (Proposition 7.1-2). It begins the analysis by presenting a simple illustration in the case of two discrete types and perfect information. The section presents how payment and allocation rules of the auction with entry fee are specified. Then, it analyzes the symmetric-equilibrium strategy and compares the expected surplus of a bidder with other auctions. Then, in the second sub-section, it completes the analysis by applying the continuous case (as presented in section 6.1.).

7.1.1. Simple Illustration with Discrete Case and Perfect Information

In this subsection, we begin the analysis by presenting a simple illustration of the case of two discrete types and perfect information. How payment and allocation rules of the auction with entry fee are specified is then presented. This is followed by analyses of the symmetric-equilibrium strategy (Proposition 7.1-1) and comparisons of the expected surplus of a bidder with other auctions (second-price sealed-bid auction and take-or-give auction without entry fee presented in the previous chapter).

More precisely, we call the auction a "*take-or-give auction with second-price payment and entry fee.*" As in a basic auction, to participate and submit bid a participating bidder must pay the *entry fee* as announced by the seller.The rule can increase the expected revenue – or *revenue-enhancing effect* – but also increase the chance of not participating from some bidders with low willingness to pay; hence, it decreases the efficiency of an auction. We call this effect the "*exclusion effect*."

In the take-or-give auction with second-price payment and entry fee, the seller announces a menu of entry fees (E_{give}, E_{take}) in which a bidder pays $E_{give} \geq 0$ if he demands to give; or pays $E_{take} \geq 0$ if he demands to take. Notice that the entry fee in this auction has two different entry fees according to the demand. This is different from the entry fee in a basic auction with only one entry fee.

The take-or-give auction with second-price payment and entry fee proceeds as follows:

The take-or-give auction with second-price payment and entry fee proceeds as follows:

1. Participation: Each bidder decides whether to participate in the auction or not.

2. Demand and Bid Submission: A participating bidder submits a doublet of *demand* of allocation and *bid*. Demand can be *take* or *give*. Also, a bid is any real number. A nonparticipating bidder neither submits a demand nor a bid.

3. Allocation: The seller allocates the object as the highest-bid bidder's demand. The obtainer could be,
   - the highest-bid bidder if he demands to *take*, or
   - his opponent if the highest-bid bidder demands to *give*, or
   - there is no obtainer if there is no participating bidder.

4. Payment: A participating bidder pays an entry fee according to his submitted demand; he pays E_{take} if his demand is taking and pays E_{give} if it is giving. The highest-bid bidder additionally pays,
   - equal to his opponent's bid when both bidders submit the same demand, or
   - there is no additional payment if they submit different demands or his opponent does not participate.

Table 7.1-1 Examples for Allocation and Payment Mechanisms in Take-or-Give Auction with Second-Price Payment and Entry Fee.

Scenario	Strategies	Allocation	Payment
1	Both demand to take. Bidder i bids 10$. Bidder j bids 7$.	Bidder i obtains.	Both pay E_{take}. Bidder i also pays 7$.
2	Both demand to give. Bidder i bids 10$. Bidder j bids 7$.	Bidder j obtains.	Both pay E_{give}. Bidder i also pays 7$.
3	Bidder i bids 10$ and demands to take. Bidder j bids 7$ and demands to give.	Bidder i obtains.	Bidder i pays E_{take}. Bidder j pays E_{give}.
4	Bidder i bids 10$ and demand to give. Bidder j does not participate.	Bidder j obtains.	Bidder i pays E_{give}. Bidder j pays nothing.

Table 7.1-2 Payoffs of Two Discrete Types Illustration.

Type	Payoffs when being the obtainer W	Payoffs when being the non-obtainer L	No obtainer
High type t_h	$W(t_h)$	$L(t_h)$	0
Low type t_l	$W(t_l)$	$L(t_l)$	0

To give some examples of the allocation and payment mechanisms, Table 7.1-1 presents four scenarios of the take-or-give auction with second-price payment and entry fee. In the 1st and 2nd scenarios, if the highest-bid bidder submits the same demand as his opponent's, they pay the corresponding fee and the highest-bid bidder pays second price; the object is allocated according to his demand. In the 3rd and 4th scenarios, respectively, if the highest-bid bidder submits a different fee from his opponent's or his opponent does not participate, he pays only the fee; the object is allocated according to his demand.

The analysis here applies the same two discrete types (high type t_h and low type t_l) as in the previous chapter (hence we can compare the results of this chapter with those of the previous one). As presented in Table 7.1-2, a high-type bidder gets $W(t_h)$ payoff if being the obtainer and $L(t_h)$ payoff if being the non-obtainer (which means that his opponent obtains the object). Similarly, a low-type bidder gets $W(t_l)$ and $L(t_l)$ payoff if being the obtainer and non-obtainer respectively. Also, if there is no obtainer, each bidder gets zero utility as status quo. We assume that $0 \leq W(t_l) < W(t_h)$ and $0 \leq L(t_h) < L(t_l)$ to capture the countervailing-positive externalities (see Figure 6.1-1 for more in-depth understanding). We also assume that the high type is the part in which utility from being the obtainer is higher than from being the non-obtainer, $W(t_h) > L(t_h)$. Additionally, the low type is the part in which the utility from being the non-obtainer is higher than from being the obtainer, $W(t_l) < L(t_l)$. The assumptions are summed in Assumption 7.1-1.

ASSUMPTION 7.1-1: $0 \leq W(t_l) < W(t_h)$, $0 \leq L(t_h) < L(t_l)$, $W(t_h) > L(t_h)$ *and* $W(t_l) < L(t_l)$.

In this situation, there are two identical bidders (hence, bidder *i* is of the same type as bidder j, $t_i = t_j \in \{t_h, t_l\}$) competing for the object in the take-or-give auction with second-price payment and entry fee under the condition of perfect information. The seller announces (E_{give}, E_{take}) as the entry fee for demand to give and for demand to take, respectively. Assume that, as in Assumption 7.1-2, the seller announces $0 \leq E_{give} \leq W(t_l)$ and $0 \leq E_{take} \leq L(t_h)$. As will be seen later, this assumption makes the seller extract surplus from externalities without affecting bidding behavior.

ASSUMPTION 7.1-2: $0 \leq E_{give} \leq W(t_l)$ *and* $0 \leq E_{take} \leq L(t_h)$.

In an auction with entry fee, bidder i submits his strategy (ρ_i, b_i, d_i) which $\rho_i \in \{P, N\}$ means that he participates ($\rho_i = P$) or does not participate ($\rho_i = N$) in the auction, $b_i \in \mathbb{R}$ is his bid and $d_i \in \{give, take\}$ is the demand. The symmetric-equilibrium strategy in this auction, $(\rho^{TGF}, b^{TGF}, d^{TGF})$, is presented in Proposition 7.1-1.

PROPOSITION 7.1-1: *In the case of two discrete types with perfect information, the symmetric-equilibrium strategy in a take-or-give auction with second-price payment and entry fee is that a high-type bidder participates with* $\frac{W(t_h)-E_{take}}{W(t_h)}$ *chance with* $W(t_h) - L(t_h)$ *bid and demand to take. A low-type bidder participates with* $\frac{L(t_l)-E_{give}}{L(t_l)}$ *chance with* $L(t_l) - W(t_l)$ *bid and demand to give.*

$$\rho^{TGF} = \begin{cases} \dfrac{W(t_h) - E_{take}}{W(t_h)} P + \dfrac{E_{take}}{W(t_h)} N \; for \; t_h \\ \dfrac{L(t_l) - E_{give}}{L(t_l)} P + \dfrac{E_{give}}{L(t_l)} N \; for \; t_l \end{cases},$$

$$b^{TGF} = \begin{cases} W(t_h) - L(t_h) \; for \; t_h \\ L(t_l) - W(t_l) \; for \; t_l \end{cases}, d^{TGF}(t) = \begin{cases} take \; for \; t_h \\ give \; for \; t_l \end{cases},$$

Proof: *See Appendix B.5.*

According to the equilibrium strategy, bidding behavior, including submitted bid and demand, in the auction with entry is the same as in the auction without entry fee (see Proposition 6.3-1). A high-type bidder submits $W(t_h) - L(t_h)$ bid as his willingness to pay and demand to take. A low-type bidder submits $L(t_l) - W(t_l)$ bid as his willingness to pay and demand to give.

As for the participation rate, since the exclusion effects of entry fees, a bidder randomly participates with $\frac{W(t_h)-E_{take}}{W(t_h)}$ for high type and $\frac{L(t_l)-E_{give}}{L(t_l)}$ for low type. Notice that the higher the entry fees, the lower the participation rates.

Next, to compare with other auctions, we derived the expected surplus and expected revenue from the auction with entry fee. We measured the expected surplus and revenue at

Table 7.1-3 Comparison of Expected Surplus and Expected Revenue in Take-or-Give Auction with Second-Price Payment and Entry Fee, Take-or-Give Auction and Second-Price Sealed-Bid Auction. (Rank from left to right: low to high for expected surplus and high to low for expected revenue).

Type Realization		Take-or-Give Auction with Entry Fee	Take-or-Give Auction	Second-Price Sealed-Bid Auction
High	Surplus	$\frac{L(t_h)\left(W(t_h)-L(t_h)\right)}{W(t_h)}$	$L(t_h)$	$L(t_h)$
	Revenue	$2\left(\frac{W(t_h)-L(t_h)}{W(t_h)}\right)*\left(L(t_h)+\frac{W(t_h)-L(t_h)}{2}\right)$	$W(t_h)-L(t_h)$	$W(t_h)-L(t_h)$
Low	Surplus	$\frac{W(t_l)\left(L(t_l)-W(t_l)\right)}{L(t_l)}$	$W(t_l)$	$\frac{2W(t_l)}{W(t_l)+L(t_l)}$
	Revenue	$2\left(\frac{L(t_l)-W(t_l)}{L(t_l)}\right)*\left(W(t_l)+\frac{L(t_l)-W(t_l)}{2}\right)$	$L(t_l)-W(t_l)$	0

the highest possible entry fees, which the seller announces as $E_{give}=W(t_l)$ and $E_{take}=L(t_h)$; recall Assumption 7.1-2 in which we have upper boundaries of entry fees.

Table 7.1-3 compares the expected surplus and expected revenue in take-or-give auction with second-price payment and entry fee, take-or-give auction and second-price sealed-bid auction (see Table 6.3-2 for the take-or-give auction and second-price sealed-bid auction). We ranked the expected surplus from low (left) to high (right) and ranked the expected revenue from high (left) to low (right). The results show that having the entry fee can increase the expected revenue. However, this is not a revenue-maximizing auction since the revenue-maximizing auction should extract all surplus.

7.1.2. Continuous Case and Imperfect Information

Here, we complete the analysis by characterizing the symmetric-equilibrium strategy in the take-or-give auction with second-price payment and entry fee in the model of continuous types and imperfect information. By applying the formal model (as presented in section 6.1.) in the take-or-give auction with entry fee, there are two risk-neutral and symmetric bidders whose types are independently and randomly drawn from $[\underline{t},\bar{t}]$. This type has distribution function F and an associated density function f.

In the auction, the seller announces (E_{give},E_{take}). Similar to the previous illustration, we assume that the entry fees have upper boundaries: $0<E_{give}\leq L(\underline{t})$ and $0<E_{take}\leq W(\bar{t})$ (in Assumption 7.1-4).

ASSUMPTION 7.1-4: $0<E_{give}\leq L(\underline{t})$ *and* $0<E_{take}\leq W(\bar{t})$.

The symmetric-equilibrium strategy $(\rho^{TGF}, b^{TGF}, d^{TGF})$ is presented in Proposition 7.1-2.

PROPOSITION 7.1-2: *In a continuous case with imperfect information, the symmetric-equilibrium strategy in a take-or-give auction with second-price payment and entry fee is that a bidder with type* $t \in (\dot{t}, \ddot{t})$ *does not participate. A bidder with type* $t \in [\ddot{t}, \bar{t}]$ *participates with* $W(t) - L(t)$ *bid and demand to take. A bidder with type* $t \in [\underline{t}, \dot{t}]$ *participates with* $L(t) - W(t)$ *bid and demand to give.*

$$\rho^{TGF}(t) = \begin{cases} N \; if \; t \in (\dot{t}, \ddot{t}) \\ P \; otherwise \end{cases}, b^{TGF}(t) = \begin{cases} W(t) - L(t) \; if \; t \in [\ddot{t}, \bar{t}] \\ L(t) - W(t) \; if \; t \in [\underline{t}, \dot{t}] \\ any \; if \; t \in (\dot{t}, \ddot{t}) \end{cases},$$

$$d^{TGF}(t) = \begin{cases} take \; if \; t \in [\ddot{t}, \bar{t}] \\ give \; if \; t \in [\underline{t}, \dot{t}] \\ any \; if \; t \in (\dot{t}, \ddot{t}) \end{cases},$$

where $\underline{t} \le \dot{t} \le t' \le \ddot{t} \le \bar{t}$ *such that* $\dot{t}, \ddot{t}$ *solves*

$$\begin{bmatrix} E_{give} = L(\dot{t}) * \left(F(\ddot{t}) - F(\dot{t})\right) \\ E_{take} = W(\ddot{t}) * \left(F(\ddot{t}) - F(\dot{t})\right) \end{bmatrix} \tag{7.1-1}$$

and t' *is defined where* $W(t') = L(t')$.

Proof: *See Appendix B.6.*

According to the proposition, Figure 7.1-1 presents the symmetric-equilibrium strategy (on the left) and allocation (on the right) in the take-or-give auction with second-price payment and entry fee. On the left, the y-axis is the bid, the x-axis is the type and the line under the x-axis denotes the participation (P and N) and selected entry fee (give for E_{give} and take for E_{take}) of each corresponding type. On the right, the x- and y-axes are the types of both bidders. (i = i obtains, j = j obtains, no = no obtainer).

The equilibrium strategy shows that the entry fee has exclusion effects which make a bidder whose type is $(\dot{t}, \ddot{t})$ not participate. As a bidder does in the auction without entry fee (see Proposition 6.3-2), a bidder with type $[\ddot{t}, \bar{t}]$ participates with a $W(t) - L(t)$ bid and demand to take and a bidder with type $[\underline{t}, \dot{t}]$ participates with a $L(t) - W(t)$ bid and demand to give.

Intuitively, like the entry fee in a basic auction, the entry fee in the take-or-give auction results in some bidders with low willingness to pay (whose types are around t') who avoid participating; recall that $W(t) - L(t)$ and $L(t) - W(t)$ are the willingness to pay of a bidder with a demand to take and to give, respectively. More precisely, with the entry fee $E_{give}, E_{take} > 0$, there are types $\dot{t} < t'$ and $\ddot{t} > t'$ which are indifferent between not participating and participating on the giving and taking sides, respectively. The types in $(\dot{t}, \ddot{t})$ are excluded from the auction with (E_{give}, E_{take}) entry fee.

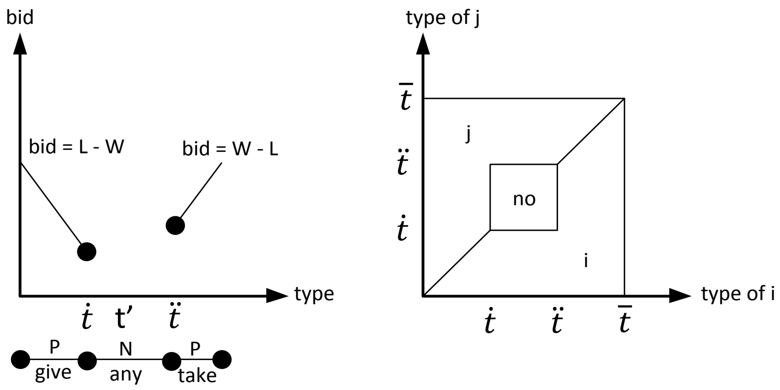

Figure 7.1-1 Symmetric-Equilibrium Strategy (on the left) and Allocation (on the right) in Take-or-Give Auction with Second-Price Payment and Entry Fee. (i = i obtains, j = j obtains, no = no obtainer).

7.2. Take-Give-Indifference Auction with Entry Fee

This section introduces more complicated rules to the take-or-give auction. These include entry fee, no sale condition and indifference demand. With the no sale condition, the seller cancels the auction if any potential bidder does not participate. With indifference demand, the bidders have the new option of demand called "*indifference demand*"; they can participate with a new indifference demand in which if all bidders submit an indifference demand, the seller randomly allocates the object with equal chance to each bidder. This auction is more specifically termed as a "*take-give-indifference auction with entry fee.*"

In the take-give-indifference auction with entry fee, the seller announces $(E_{give}, E_{take}, E_{pool})$ in which a bidder with a taking demand pays E_{take}; a bidder with a giving demand pays E_{give}; a bidder with an indifference demand pays E_{pool}. The auction process is as follows:[31]

1. Participation: Each bidder decides whether to participate in the auction or not. If there is a non-participating bidder, the auction is cancelled.
2. Demand and Bid Submission: A participating bidder submits a doublet of *demand* of allocation and *bid*. Demand can be *take*, *give* or *indifference*. Also, a bid is any real number.
3. Allocation: If all bidders submit indifference demands, the object is randomly allocated to each of the bidders with equal probability. Otherwise, the seller selects the highest-bid bidder's demand which is not an indifference demand and allocates the object accordingly.
4. Payment: Each bidder pays an entry fee according to his submitted demands; he pays E_{take} if his demand is taking, pays E_{give} if it is giving and pays E_{pool} if it is

[31] The auction is similar to a *two-part tariff*. As in the traditional case of a two-part-tariff amusement park where a consumer pays entry fee to enter the park and additionally pays a ticket to ride a plaything, the auction lets a bidder pay E_{pool} to enter the auction and additionally pay a demand-to-take ticket as $E_{take} - E_{pool}$ plus second-price payment (if the case is applicable), and vice versa for a demand-to-give ticket.

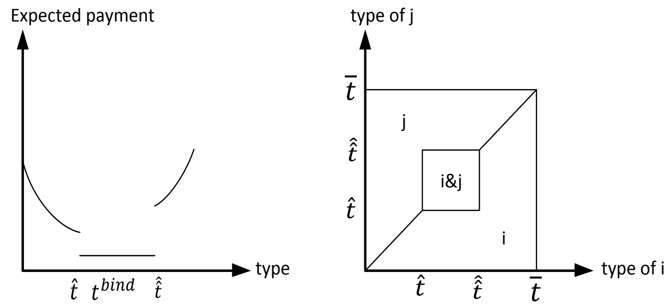

Figure 7.2-1 Expected Payment (on the left) and Allocation (on the right) of the Optimal Auction in Chen and Potipiti (2010). (i = i obtains, j = j obtains, i&j = each bidder has 0.5 chance of being obtainer).

indifference. If both bidders submit the same taking or giving demand, the highest-bid bidder additionally pays equal to his opponent's bid. Otherwise, there is no additional payment.

The rules are introduced because of the following motivations: i) In the optimal auction of Chen and Potipiti (2010) (see Figure 7.2-1 on the left), expected payment can be separated into three parts: decreasing (on the left), constant (in the middle) and increasing (on the right). When compared with the equilibrium strategy in the take-or-give auction with entry fee (see Figure 7.1-1 on the left), the auction creates similar bid behavior (which directly implies the expected payment). The only difference is in the middle part whereby in the auction a bidder does not participate and pays nothing due to the exclusion effects. The new rules try to recruit a bidder in the middle part to participate with a constant payment. ii) In the optimal auction, when both bidders have types in the middle part, they have equal chance to obtain the object (see Figure 7.2-1 on the right). When compared with the allocation in the take-or-give auction with entry fee (see Figure 7.1-1 on the right), if both bidders have types in the middle part the seller keeps the object. Having the indifference demand is possible to induce the same outcome at the middle part as in the optimal auction. iii) As discussed in Jehiel et al. (1996), the optimal rules should "*leave a nonparticipating buyer with the lowest possible level of utility*"; the no sale condition leaves a non-participating bidder with the lowest possible level of utility (which is zero) since the auction is canceled (see section 5.2., Chapter V, for more discussion about the optimal auction of Chen and Potipiti (2010)).

Table 7.2-1 presents seven scenarios as examples of the allocation and payment mechanisms in the take-give-indifference auction with entry fee. In the 1st-5th scenarios, there are some bidders whose demands are taking or giving. The highest-bid bidder whose demand is taking or giving pays the fee and the object is allocated according to his demand. He pays the second price if his opponent submits the same demand (in scenarios 1st and 2nd). In the 6th scenario, all bidders' demands are indifference and, regardless of their bids, the object is randomly allocated with equal probability and bidders pay only the fee. In the 7th scenario, the auction is cancelled since some bidders do no participate, bidders pay nothing and the seller keeps the object.

This section characterizes the symmetric-equilibrium strategy in the take-give-indifference auction with entry fee (Proposition 7.2-1). Since it is too complicated to present

Table 7.2-1 Examples of Allocation and Payment Mechanisms in the Take-Give-Indifference Auction with Entry Fee.

Scenario	Strategies	Allocation	Payment
1	Both demand to take. Bidder i bids 10\$. Bidder j bids 7\$.	Bidder i obtains.	Both pay E_{take}. Bidder i also pays 7\$.
2	Both demand to give. Bidder i bids 10\$. Bidder j bids 7\$.	Bidder i gives. Bidder j obtains.	Both pay E_{give}. Bidder i also pays 7\$.
3	Bidder i bids 10\$ and demands to take. Bidder j bids 7\$ and demands to give.	Bidder i obtains.	Bidder i pays E_{take}. Bidder j pays E_{give}.
4	Bidder i bids 10\$ and demands to take. Bidder j bids 7\$ and indifference demand.	Bidder i obtains.	Bidder i pays E_{take}. Bidder j pays E_{pool}.
5	Bidder i bids 10\$ and indifference demand. Bidder j bids 7\$ and demands to give.	Bidder j gives. Bidder i obtains.	Bidder i pays E_{pool}. Bidder j pays E_{give}.
6	Both submit indifference demand. Bidder i bids 10\$. Bidder j bids 7\$.	0.5 chance to obtain.	Both pay E_{pool}.
7	Bidder i bids 10\$ and demand to give. Bidder j does not participate.	Nobody obtains.	Both pay nothing.

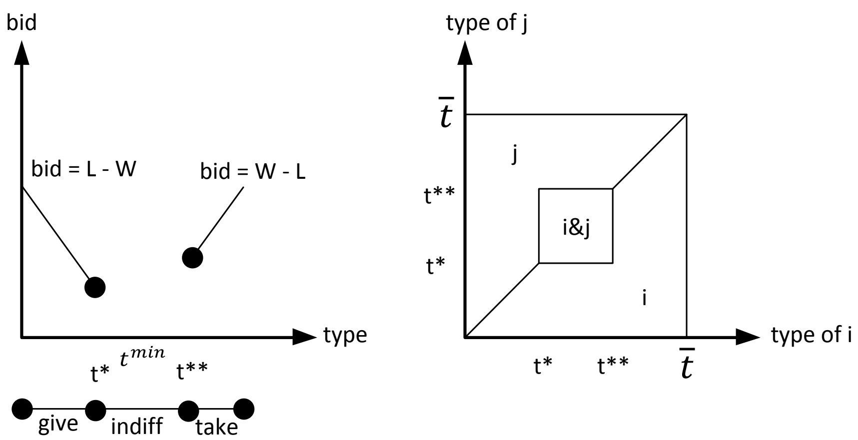

Figure 7.2-2 Symmetric-Equilibrium Strategy and Allocation in the Take-Give-Indifference Auction with Entry Fee. (i = i obtains, j = j obtains, i&j = each bidder has 0.5 chance of being obtainer).

the equilibrium strategy by applying a discrete case with perfect information, we characterize the equilibrium strategy only for the case of continuous type with imperfect information.

Recall our model from section 6.1. In the model, there are two risk-neutral and symmetric bidders whose types are independently and randomly drawn from $[\underline{t}, \bar{t}]$. The type has distribution function F and an associated density function f.

In the take-give-indifference auction with entry fee $(E_{give}, E_{take}, E_{pool})$, we assume that the entry fees are characterized by (7.2-1) in Assumption 7.2-1. (This assumption is a sufficient condition for our following equilibrium).

ASSUMPTION 7.2-1: *In the take-give-indifference auction with entry fee, the entry fees* $(E_{give}, E_{take}, E_{pool})$ *announced by the seller are feasible if (7.2-1) is satisfied,*

$$\begin{bmatrix} t^{min} = F^{-1}\left(\frac{b}{a+b}\right) \\ E_{pool} = \int_{\underline{t}}^{t^*} W(t^{min})dF(t) + \int_{t^*}^{t^{**}} \frac{1}{2}\left(W(t^{min}) + L(t^{min})\right)dF(t) + \int_{t^{**}}^{\bar{t}} L(t^{min})dF(t) \\ E_{give} = E_{pool} + \int_{t^*}^{t^{**}} \frac{1}{2}\left(L(t^*) - W(t^*)\right)dF(t) \\ E_{take} = E_{pool} + \int_{t^*}^{t^{**}} \frac{1}{2}\left(W(t^{**}) - L(t^{**})\right)dF(t) \\ \int_{\underline{t}}^{t^*} W(t^*)dF(t) + \int_{t^*}^{\bar{t}} L(t^*)dF(t) \geq E_{give} \\ \int_{\underline{t}}^{t^{**}} W(t^{**})dF(t) + \int_{t^{**}}^{\bar{t}} L(t^{**})dF(t) \geq E_{take} \end{bmatrix} \qquad (7.2-1)$$

for some t^*, t^{**} *such that* $\underline{t} \leq t^* \leq t^{min} \leq t^{**} \leq \bar{t}$.

In the auction, bidder i has his strategy (ρ_i, b_i, d_i) which $\rho_i \in \{P, N\}$ means that he participates ($\rho_i = P$) or does not participate ($\rho_i = N$) in the auction, $b_i \in \mathbb{R}$ is his bid and $d_i \in \{give, take, indifference\}$ is the demand. The symmetric-equilibrium strategy $(\rho^{TGI}, b^{TGI}, d^{TGI})$ is presented in Proposition 7.2-1.

PROPOSITION 7.2-1: *In the continuous case and imperfect information, with the menu of entry fees as specified in (7.2-1), the symmetric-equilibrium strategy in a take-give-indifference auction with entry fee is that all bidders participate. A bidder with type* $t \in [t^{**}, \bar{t}]$ *submits a* $W(t) - L(t)$ *bid and demand to take. A bidder with type* $t \in [\underline{t}, t^*]$ *submits a* $L(t) - W(t)$ *bid and demand to give. A bidder with type* $t \in (t^*, t^{**})$ *submits any bid with indifference demand.*

$$\rho^{TGI} = P \,, b^{TGI}(t) = \begin{cases} W(t) - L(t) \; if \; t \in [t^{**}, \bar{t}] \\ L(t) - W(t) \; if \; t \in [\underline{t}, t^*] \\ any \; if \; t \in (t^*, t^{**}) \end{cases}, d^{TGI}(t) = \begin{cases} take \; if \; t \in [t^{**}, \bar{t}] \\ give \; if \; t \in [\underline{t}, t^*] \\ indifference \; if \; t \in (t^*, t^{**}) \end{cases}$$

Proof: *See Appendix B.7.*

According to the equilibrium strategy, Figure 7.2-2 presents the symmetric-equilibrium strategy (on the left) and allocation (on the right) in the take-give-indifference auction with entry fee. On the left, the y-axis is the bid, the x-axis is the type and the line under the x-axis denotes the selected demand of each corresponding type. On the right, the x- and y-axes are the types of both bidders.(i = i obtains, j = j obtains, i&j = each bidder has 0.5 chance of being the obtainer).

Notice that the auction yields similar expected payment and allocation to that of the optimal auction of Chen and Potipiti (2010) (as presented in Figure 7.2-1). According to the equilibrium strategy, the types are classified into three groups according to the submitted demand. That is, the *indifference group* (t^*, t^{**}) is in the middle region including t^{min} and some neighbors. They participate with indifference demands and any bids and pay constant expected payments. The *taking group* $[t^{**}, \bar{t}]$ is on the taking side (toward the highest type) and participates with the demand to take and bid as their willingness to pay $W(t) - L(t)$. A bidder in the taking group pays increasing expected payment in type. Last, the *giving group* $[\underline{t}, t^*]$ is on the giving side (toward the lowest type) and participates with the demand to give and bid as their willingness to pay $L(t) - W(t)$. A bidder in the giving group pays decreasing expected payment in type.

The type t^{min} is the binding type in this auction. The binding type gets zero surplus as status quo; other non-binding types are left with positive surplus as information rent. For type t^*, a bidder with type t^* feels indifference between submitting an indifference demand and a giving demand with $L(t^*) - W(t^*)$. Similarly, a bidder of type t^{**} feels indifference between submitting an indifference demand and a taking demand with $W(t^{**}) - L(t^{**})$ bid.

7.2.1. Take-Give-Indifference Auction with Single Entry Fee

From the previous analysis, we can see that, in terms of practicability, the implementation of the take-give-indifference auction with entry fee $(E_{give}, E_{take}, E_{pool})$ is quite complicated. In this section, we present a corollary with the auction having only a single entry fee and which is far less complicated in its implementation.

Recall the Assumption 7.2-1 which characterizes the menu of entry fees $(E_{give}, E_{take}, E_{pool})$. The seller can announce a single entry fee such that $E_{give} = E_{take} = E_{pool}$; as a consequence, the single entry fee also makes $t^* = t^{min} = t^{**}$. The symmetric-equilibrium strategy in the take-give-indifference auction with single entry fee $(\rho^{TGIS}, b^{TGIS}, d^{TGIS})$ is a corollary of Proposition 7.2-1. The equilibrium strategy is as follows:

COROLLARY 7.2-1: *Suppose the seller announces a single entry fee such that $E_{give} = E_{take} = E_{pool}$ and the entry fees are characterized by (7.2-1), all bidders participate. A bidder with type $t \in [\underline{t}, t^{min}]$ submits the demand to give and a $L(t) - W(t)$ bid. A bidder with type $t \in (t^{min}, \bar{t}]$ submits the demand to take and a $W(t) - L(t)$ bid.*

$$\rho^{TGIS} = P\ , b^{TGIS}(t) = \begin{cases} W(t) - L(t)\ if\ t \in (t^{min}, \bar{t}] \\ L(t) - W(t)\ if\ t \in [\underline{t}, t^{min}] \end{cases}, d^{TGIS}(t) = \begin{cases} take\ if\ t \in (t^{min}, \bar{t}] \\ give\ if\ t \in [\underline{t}, t^{min}] \end{cases},$$

Referring to the equilibrium strategy, we can see that the take-give-indifference auction with single entry fee is the *efficient auction* (Corollary 7.2-2).

COROLLARY 7.2-2: *The take-give-indifference auction with single entry fee is an efficient auction.*

7.3. Revenue Comparison

Here, a comparison is presented of the expected revenue from each auction presented in Chapter VI (including second-price sealed-bid auction and simple take-or-give auction with second-price payment) and in Chapter VII (including take-or-give auction with entry fee and take-give-indifference auction with entry fee). The previous sections of this chapter characterized the symmetric-equilibrium strategies in the take-or-give auction with entry fee (Proposition 7.1-2), in the take-give-indifference auction (Proposition 7.2-1) and in the take-give-indifference auction with single entry fee (Corollary 7.2-1). The previous Chapter VI also characterized the equilibrium strategies in the simple take-or-give auction (Proposition 6.3-2) and second-price sealed-bid auction (Proposition 6.2-2).

According to the equilibrium strategy of each auction, we can derive the expected revenue. For the take-give-indifference auction with entry fee, from the equilibrium strategy (Proposition 7.2-2), the seller gets the expected revenue as

$$ER^{TGI} = 2 * \left[\int_{\underline{t}}^{t^*}\left[E_{give} + \int_{x}^{t^*}\big(L(t) - W(t)\big)dF(t)\right]dF(x) + \int_{t^*}^{t^{**}} E_{pool}dF(x) + \int_{t^{**}}^{\bar{t}}\left[E_{take} + \int_{t^{**}}^{x}\big(W(t) - L(t)\big)dF(t)\right]dF(x)\right] \qquad (7.3-1)$$

where, in the bracket, the first to third terms are the expected payment when a bidder has type $x \in [\underline{t}, t^*]$, $x \in (t^*, t^{**})$ and $x \in [t^{**}, \bar{t}]$ respectively; and the whole bracket is multiplied by two since there are two bidders. The optimal revenue from the auction is obtained when the seller designs the optimal menu of entry fees $\left(E_{give}{}^*, E_{take}{}^*, E_{pool}{}^*\right)$ by solving Problem 7.3-1,

PROBLEM 7.3-1

$$\max_{E_{give}, E_{take}, E_{pool}} ER^{TGI}$$
$$s.t.$$
$$(7.2-1)$$

For the take-give-indifference auction with single entry fee, the equilibrium strategy (Corollary 7.2-1) shows that the expected revenue is

$$ER^{TGIS} = 2 * \left[\int_{\underline{t}}^{t^{min}}\left[E_{give} + \int_{x}^{t^{min}}\big(L(t) - W(t)\big)dF(t)\right]dF(x) + \int_{t^{min}}^{\bar{t}}\left[E_{take} + \int_{t^{min}}^{x}\big(W(t) - L(t)\big)dF(t)\right]dF(x)\right] \qquad (7.3-2)$$

where the first and second terms are the expected payment when a bidder is of type $x \in [\underline{t}, t^{min}]$ and $x \in (t^{min}, \bar{t}]$ respectively. In this auction, there is only one solution in the menu such that $E_{give} = E_{take} = E_{pool}$. Hence, there is no optimization problem to be solved.

For the take-or-give auction with entry fee, the equilibrium strategy (Proposition 7.1-2) shows that the expected revenue is

$$ER^{TGF} = 2 * \left[\int_{\underline{t}}^{\dot{t}} \left[E_{give} + \int_{x}^{\dot{t}} \big(L(t) - W(t)\big) dF(t) \right] dF(x) \right.$$
$$\left. + \int_{\ddot{t}}^{\bar{t}} \left[E_{take} + \int_{\ddot{t}}^{x} \big(W(t) - L(t)\big) dF(t) \right] dF(x) \right] \qquad (7.3-3)$$

where the first and second terms are the expected payment when a bidder is of type $x \in [\underline{t}, \dot{t}]$ and $x \in [\ddot{t}, \bar{t}]$ respectively. In the auction, to get the highest revenue the seller designs the optimal menu $(E_{give}{}^{*}, E_{take}{}^{*})$ by solving the optimization Problem 7.3-2,

PROBLEM 7.3-2

$$\max_{E_{give}, E_{take}} \; ER^{TGF}$$
$$s.t.$$
$$(7.1-1)$$

For the simple take-or-give auction, the equilibrium strategy (Proposition 6.3-2) shows that the expected revenue is

$$ER^{TG} = 2 * \left[\int_{\underline{t}}^{t'} \int_{x}^{t'} \big(L(t) - W(t)\big) dF(t)\, dF(x) \right.$$
$$\left. + \int_{t'}^{\bar{t}} \int_{t'}^{x} \big(W(t) - L(t)\big) dF(t)\, dF(x) \right] \qquad (7.3-4)$$

where the first and second terms are the expected payment when a bidder is of type $x \in [\underline{t}, t']$ and $x \in (t', \bar{t}]$ respectively.

Lastly, for the second-price sealed-bid auction, the equilibrium strategy (Proposition 6.2-2) shows that the expected revenue is

$$ER^{S} = 2 * \int_{t'}^{\bar{t}} \int_{t'}^{x} \big(W(t) - L(t)\big) dF(t)\, dF(x). \qquad (7.3-5)$$

To compare the expected revenue of each auction proposed in this study with the optimal revenue of the optimal auction in Chen and Potipiti (2010), we applied the same example given in their work – the case of selling retaliation rights in the WTO. The numerical example specifies the utility function, type interval and distribution function as presented in (7.3-6),

$$\begin{bmatrix} \underline{t} = 1, \bar{t} = 2, F(t) = t - 1 \\ W(t) = -\dfrac{1}{96} + \dfrac{1}{48} t \\ L(t) = \dfrac{13}{288} - \dfrac{1}{48} t \\ ER^{O} = \dfrac{5}{128} \end{bmatrix} \qquad (7.3-6)$$

where ER^{O} is the optimal revenue from the optimal auction in Chen and Potipiti (2010).

Table 7.3-1 Comparison of Expected Revenue and Efficiency. (S = second-price sealed-bid auction, TG = simple take-or-give auction, TGF = take-or-give auction with entry fee, TGIS = take-give-indifference auction with single entry fee and TGI = take-give-indifference auction with entry fee).

Auction	S	TG	TGF	TGIS	TGI	Optimal Auction
Revenue	$\frac{1}{243}$	$\frac{1}{216}$	$\frac{2}{141}$	$\frac{11}{288}$	$\frac{5}{128}$	$\frac{5}{128}$
Efficient (Yes/No)	No	Yes	No	Yes	No	No

We apply the example in (7.3-6) to the expected revenue of each auction as presented in (7.3-1) to (7.3-5). The expected revenue and efficiency of each auction are presented in Table 7.3-1. The table ranks the expected revenues from the lowest in the second-price sealed-bid auctionto the highest in the optimal auction of Chen and Potipiti (2010). Notice that i) when we change from a basic second-price sealed-bid auction to the simple take-or-give auction, the problem of inefficient allocation is fixed and the revenue is increased. ii) When the take-or-give auction is introduced with the entry fee, it yields higher revenue but is inefficient due to the exclusion effects. iii) When the entry fee, no sale condition and indifference demand are introduced, with a single entry fee the auction makes efficient allocation and the revenue is increased. Comparison between efficient auctions (simple take-or-give auction and take-give-indifference auction with single entry fee) reveals that the auction with single entry fee yields higher revenue. iv) Lastly, in the take-give-indifference auction with entry fee, when we allow for multi entry fees, the auction is inefficient but yields revenue as the optimal level ER^O.

Further to this, the take-give-indifference auction with entry fee is analytically proven for its equivalence to the optimal auction of Chen and Potipiti (2010). The analysis shows that the auction is equivalent to the optimal auction. Hence, it is a *revenue-maximizing auction* (Proposition 7.3-1).

PROPOSITION 7.3-1: *The take-give-indifference auction with entry fee is a revenue-maximizing auction for an object with countervailing-positive externalities.*
Proof: *See Appendix B.8.*

7.4. Conclusions

This chapter presents three extended take-or-give auctions with revenue-enhancing rules. First, with entry fee E_{give} and E_{take}, the auction has exclusion effects on both demand-to-take and demand-to-give sides. A bidder with low willingness to pay a bidder whose type is around t' (recall that t' is the type in which $W(t') = L(t')$ hence the willingness to pay is zero and is the lowest) does not participate in the auction with entry fee (Proposition 7.1-2). The outcome of the auction is inefficient since if both bidders have types in the non-participation interval $(\dot{t}, \ddot{t})$ the seller keeps the object; if any bidder has a type outside the interval, the highest-type bidder obtains it. Even though the auction is inefficient, having the fee yields higher revenue since the seller can extract more surplus from the externalities (see Table 7.3-1).

Second, entry fee, no sale condition and indifference demand are introduced to the take-or-give auction. This is referred to as the "*take-give-indifference auction with entry fee.*" The no sale condition threatens a nonparticipating bidder since not participating means the auction is canceled and leaves him zero utility. The indifference demand allows a bidder to participate either in preventing the cancellation or taking some chance of being the obtainer. Also, the entry fee directly extracts surplus from the externalities. With the menu of entry fee $(E_{give}, E_{take}, E_{pool})$ as specified in (7.2-1), the equilibrium strategy shows that a bidder's behavior is classified into three groups: low-, middle- and high-type groups. With low-type group, $t \in [\underline{t}, \dot{t}]$, a bidder submits a giving demand and a $L(t) - W(t)$ bid; with middle-type group, $t \in (\dot{t}, \ddot{t})$, a bidder submits an indifference demand and any bid; with the high-type group, $t \in [\ddot{t}, \bar{t}]$, a bidder submits a taking demand and a $W(t) - L(t)$ bid. According to the equilibrium strategy, the auction induces an outcome in which the seller always sells the object. If both bidders are of the middle type, the object is randomly allocated with equal chance. Otherwise, the highest-type bidder always obtains it. The auction is inefficient but maximizes expected revenue (Proposition 7.3-1).

Since the take-give-indifference auction with entry fee is complicated in its implementation, we present a special case of the auction in which the seller announces only a single entry fee. This is referred to as the "*take-give-indifference auction with single entry fee.*" Even though the auction is not a revenue-maximizing auction, it yields higher revenue than the take-or-give auction with entry fee. Also, it is an efficient auction and it yields higher revenue than the simple take-or-give auction which is also an efficient auction.

For a seller concerned about the efficiency of allocation, this study proposes two efficient auctions: the simple take-or-give auction and the take-give-indifference auction with single entry fee. Even though the take-give-indifference auction with entry fee yields higher revenue, it is less practical because of its sophisticated rules. For a seller concerned about revenue (Table 7.3-1 compares the revenue from each auction), the level of revenue is increased when more sophisticated rules are introduced into the auction. The seller must trade-off between practicability and revenue.

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APPENDICES

APPENDIX A

A.1. Experiment Protocol

This study recruited sixty-four economic and fifteen non-economic undergraduate students (n=79). The subjects voluntarily participated in a four-session hand-run economic experiment (one subject participated once) that was double-blindly conducted. The experiment was organized during August and September 2011 at Chulalongkorn University, Thailand. Subjects knew the experiment from printed and social-network distributed announcements that provided necessary information especially session length, payment and activities.

To make them concerned cost and benefit of the participation, session length (one and a half hour) and minimum-maximum payment (100-400 baht) were informed in announcements. Moreover, the announcements informed that activities would compose of providing information in questionnaires and making decisions in various situations where the payment was depended on each subject’s decisions and other subjects' decisions in the experiment that had four sessions. On average, the experiment paid 33 baht/hour which is higher than the minimum wage per hour.[32]

The payment was divided into two parts: shown-up fee (50 baht) and payment from decisions. The announcements informed that subjects would get paid within a month after the experiment end, but did not inform the payment process; this is to avoid subjects who only wanted the shown-up fee and unlikely to make decisions. Subjects knew the payment process after all decisions had been made.

In each session, subjects did three types of tasks: providing information in questionnaires, deciding in a dictator game, and deciding in eight trust games (which three games are presented here and six games in Essay B). The experiment applies strategy method that subjects contingently made decisions as both roles and in all games. Before making decisions in trust games, subjects were required to answer some questions to help them understand the game. To make them push more effort in understanding the game, a subject who correctly answered all questions got paid. Staff checked each subject's answers, publicly announced key of the questions and publicly answered some questions concerning the games but did not answer questions that would affect subjects' decision makings in the games.

This study introduced framing-effect-free and anonymous environment. By using bias-free words like "*situation*" instead of "*game*", "*person*" instead of "*player*", "*decision A*" instead of "*stop*", etc., framing-effect-free environment was introduced to make treatments were -- *neutral*, a subject was not convinced that a treatment was either game or reciprocity-related situation. Second, to prevent being confounded by changing decision according to

[32] According to the Thai law, in year 2011, the minimum wage per day in Bangkok was 215 baht which was equal to about 20 baht/hour (1 day = 12 work hours).

opponents that, for instance, subject may likely to reciprocate friendly more than rivalry opponent, anonymous environment was introduced by informing that each subject's opponents would be randomly drawn from more than fifty participants in this experiment; no one knew one's opponents, the opponents were -- *anonymous*.

Last, this study concerned another important theoretical assumption, independent decisions between games. Eight trust games were separated into four sets (two games per set) and inserted in an envelope. Staff handed the envelope over each subject, announced rules and regulations, monitored subjects' behaviors, and warned them against violating the rules; however, there was no punishment for any violation. The rules and regulations that were announced is as following: draw only one set at a time, finish and return the current set to your envelop before the next set are drawn and changing any decision in finished sets are prohibited.

A.2. DK model and Derivation of (4.1-1) and (4.1-2)

$$\begin{bmatrix} u_i(z_i, z_j, \beta_{ij}, \beta_{iji}, \varepsilon_i^i, \varepsilon_j^i; \emptyset_i) = m_i(z_i, z_j) + \emptyset_i \cdot G_i(z_i, \beta_{ij}, \varepsilon_j^i) \cdot P_i(\beta_{ij}, \beta_{iji}, \varepsilon_i^i) \\ G_i = E_i[m_j] - \varepsilon_j^i \\ P_i = E_i[m_i] - \varepsilon_i^i \\ \varepsilon_j^i = \frac{1}{2}(E_{max,i}[m_j] + E_{min,i}[m_j]) \\ \varepsilon_i^i = \frac{1}{2}(E_{max,i}[m_i] + E_{min,i}[m_i]) \end{bmatrix} \quad (A.2-1)$$

The DK model is a psychological reciprocity model which was proposed by Dufwenberg and Kirchsteiger (2004). Suppose there be two agents i and j -- one is the giver and the other is the receiver -- as presented in (A.2-1), the model explains how the agent i derives his utility u_i in a reciprocity-related situation. The term m_i is the *material payoffs* which are determined by the decisions of both agents, or the strategy profile (z_i, z_j).

The second term $\emptyset_i \cdot G_i \cdot P_i$ is the relatively weighted *psychological payoffs*. The term composes of i) the *reciprocity parameter of* i^{th} *agent* $\emptyset_i \geq 0$ as the relative weight between material and psychological payoffs (notice that if $\emptyset_i = 0$ the agent is the pure self-interested type), ii) *kindness giving* G_i which means how much kindness the agent i (as the giver) gives the receiver j and iii) *kindness perceiving* P_i which means how much kindness the agent i (as the receiver) perceives kindness from the giver j. (Notice that for each agent he plays both roles as giver and receiver; this is the nature of reciprocity).

As mentioned, in a psychological model, beliefs of an agent play important roles in determining decisions. In the DK model, each agent has two types of beliefs: β_{ij} is the belief of agent i on the agent j's decision and β_{iji} is the belief of agent i on the agent j's beliefs on agent *i*'s decision. Notice that, these beliefs affect the agent's psychological payoffs, which derived from emotional experience.

Next, we will see how the DK model define measurement of the kindness giving and kindness perceiving functions. To measure the kindness giving, by deriving from his beliefs and decision, the giver i measures his kindness that he gives to receiver j by measuring the difference between the expected material payoffs of the receiver j, $E_i[m_j]$, and the equitable payoffs of the receiver j, ε_j^i. Notice that, both the expected and equitable payoffs are affected by the beliefs of giver *i*; hence we apply $E_i[\cdot]$ and $\varepsilon_{\cdot}^i$ to show that their values depend on giver *i*'s beliefs.

Given giver i's <u>beliefs</u>, if his decision makes receiver j get higher expected material payoffs than the equitable payoffs, he gives kindness to receiver j. On the opposite, if his decision makes receiver j get lower expected material payoffs than the equitable payoffs, he gives unkindness to receiver j. To measure the kindness and unkindness giving in the DK model, the equitable payoffs is the reference point which is similar to zero point on the real line. Hence, if giver i gives kindness, $E_i[m_j] \geq \varepsilon_j^i$, then $G_i \geq 0$; otherwise, if he gives unkindness, $E_i[m_j] < \varepsilon_j^i$, then $G_i < 0$.

Giver i derives the receiver *j*'s equitable payoffs ε_j^i from the arithmetic mean between possible maximum and minimum of the receiver *j*'s material payoffs under his beliefs ($E_{max,i}[m_j]$ and $E_{min,i}[m_j]$ respectively).

Similarly, to measure the kindness perceiving, by deriving from his beliefs, the receiver i measures the difference between the expected material payoffs of himself, $E_i[m_i]$, and the equitable payoffs of himself, ε_i^i. Given receiver *i*'s beliefs, if the giver *j*'s decision makes $E_i[m_i] \geq \varepsilon_i^i$ then the giver gives receiver i kindness and the receiver *perceives kindness* $P_i \geq 0$; otherwise, if the decision makes $E_i[m_i] < \varepsilon_i^i$ then the giver gives unkindness and the receiver *perceives unkindness* $P_i < 0$.

Notice that the reciprocal payoffs are derived by the interaction between kindness giving and perceiving. Intuitively, if the agent perceives kindness then he is more likely to return kindness. And, if the agent perceives unkindness then he is more likely to return unkindness. By specifying the product operator as the interaction between kindness giving and kindness perceiving, the DK model satisfies the intuition. Precisely, if the agent i perceives kindness $P_i \geq 0$ then it is optimal for him to return kindness; since returning kindness makes $G_i \geq 0$ and increases his utility (since $G_i \cdot P_i \geq 0$). On the contrary, if the agent i perceives unkindness $P_i < 0$ then it is optimal for him to return unkindness; since returning unkindness makes $G_i < 0$ and increases the utility (since $G_i \cdot P_i \geq 0$).

A.3. Derivation of (4.2-1)

The following in this section, we derive the receiver's best response (4.2-1). Recall the positive-reciprocity trust game as presented in Figure 4.2-1. Under the DK model in (A.2-1), the receiver (as the second player) has his belief system $(\beta_{21}, \beta_{212})$ where $\beta_{21} \in [0,1]$ is the receiver's belief on the giver's probability of stopping the game and $\beta_{212} \in [0,1]$ is the receiver's belief on the giver's belief on the receiver's probability of choosing taking. To derive the receiver's utility, also let $z_1 \in [0,1]$ be the giver (as the first player)'s probability of stopping the game and $\beta_{121} \in [0,1]$ be the giver's belief on the receiver's belief on the giver's probability of stopping the game; and, let $z_2 \in [0,1]$ be the receiver's probability of choosing taking and $\beta_{12} \in [0,1]$ be the giver's belief on the receiver's probability of choosing taking. We can derive

$$\begin{bmatrix} m_2 = bz_1 + (1 - z_1)\big((b + d)z_2 + (1 - z_2)(b + d - e)\big) \\ E_2[m_1] = a\beta_{21} + (1 - \beta_{21})\big(cz_2 + (1 - z_2)(c + e)\big) \\ E_2[m_2] = b\beta_{21} + (1 - \beta_{21})\big((b + d)\beta_{212} + (1 - \beta_{212})(b + d - e)\big) \end{bmatrix}. \qquad (A.3-1)$$

From the model, in the kindness-giving function, the equitable payoffs depend on $E_{max,2}[m_1]$ and $E_{min,2}[m_1]$ which are controllable by the receiver. To find $E_{max,1}[m_2]$ and $E_{min,1}[m_2]$, the receiver chooses his decisions to maximize and minimize $E_2[m_1]$ respectively. Precisely, $E_{max,2}[m_1] = E_2\big[m_1 \big| z_2^{max} \in \operatorname{argmax}_{z_2} E_2[m_1]\big]$ and vice versa for $E_{min,2}[m_1]$. Hence, $z_2^{max} = 0$ and $z_2^{min} = 1$.

Similarly, in the kindness-perceiving function, the equitable payoffs depend on $E_{max,2}[m_2]$ and $E_{min,2}[m_2]$ which are controllable by the giver. Hence, the receiver measures $E_{max,2}[m_2]$ by believing that the giver chooses his decision to maximize $E_2[m_2]$. Precisely, $E_{max,2}[m_2] = E_2\big[m_2 | \beta_{21}^{max} \in \operatorname{argmax}_{\beta_{21}} E_{max,2}[m_2]\big]$. Hence, $\beta_{21}^{max} = 0$. Vice versa for $E_{min,2}[m_2]$, we get $\beta_{21}^{min} = 1$. Therefore, we can the receiver's utility function

$$u_2 = [b + d - (1 - z_2)e] + \emptyset_2\left[\left(\frac{1}{2} - z_2\right)e\right]\left[\frac{1}{2}(d - (1 - \beta_{212})e)\right]. \qquad (A.3-2)$$

From (4.1-1), the receiver derives his utility from two parts: material-payoff part which is in the first blanket and psychological-payoff part which is in the second and third blankets. Precisely, at the receiver's decision, if he chooses taking then he gets $b + d$ material payoffs (since in the game money or monetary payoffs defines the material payoffs, the term monetary and material are interchangeable); if he chooses returning then he gets $b + d - e$ material payoffs. Therefore, we get the first blanket as the expectation on the receiver's material payoffs that he get from choosing taking with probability z_2.

The second blanket means how much kindness the receiver returns to the giver. This represents, as called by the DK model, *kindness giving*. To measure kindness or unkindness, the DK model proposed that there is a reference point which agent feels neutral: not neither kindness nor unkindness. The point is called *equitable point.* The model simply proposed that the equity point is the arithmetic mean between the highest and lowest possible material payoffs which can be induced. In this case, the receiver can choose taking which return zero point or choose returning which return e points. Hence, the equitable point is $\frac{1}{2}e$. And, if the receiver chooses *returning* then he gives the giver *kindness* which the second blanket shows *positive* value. In the opposite, if the receiver chooses *taking* then he gives the giver *unkindness* which the second blanket shows *negative* value. Hence, the model measures the kindness giving as the expectation on difference of the returned points and the equitable point given the receiver chooses taking with probability z_2; we get the second blanket.

The third blanket means how much kindness the receiver perceives that the giver gave him. This represents *kindness perceiving.* To measure the kindness perceiving, the receiver derives it under his beliefs on the giver's beliefs. Precisely, the receiver believes that the giver believes that he will choose taking and get $b + d$ material payoffs then he will compare the amount of payoffs he will get with an equitable point (which is not the same point as in kindness giving); under his beliefs, if the receiver will get more than the equitable point then he perceives kindness and derives positive value of the third blanket; and vice versa. The equitable point is, similarly, measured by the arithmetic mean between the possible highest and lowest points that the receiver can obtain under his beliefs. In this case, under his belief β_{212}, the possible lowest is b and the possible highest is $b + d + (1 - \beta_{212})e$. Therefore, the equitable point is $\frac{1}{2}(2b + d + (1 - \beta_{212})e)$. Hence, at his decision node, the receiver always perceives kindness (since $e < d$, $\frac{1}{2}(d - (1 - \beta_{212})e) > 0$ for any β_{212}). This is the feature of positive-reciprocity trust game where the giver's continuing always makes the receiver be better. To derive the third blanket, given the receiver's belief β_{212}, he gets expectation on his material payoffs compared with the equitable point as $\beta_{212}(b + d) + (1 - \beta_{212})(b + d - e) - \frac{1}{2}(2b + d + (1 - \beta_{212})e) = \frac{1}{2}(d - (1 - \beta_{212})e)$ which is the third blanket.

The model specifies that the receiver derives his reciprocal payoffs from the product of kindness giving and kindness perceiving. This specification captures the essence of reciprocity. Precisely, If the receiver perceives kindness which yields positive value of the third blanket, then he prefers to reciprocally return the giver favors which yields positive value of the second blanket and yields higher utility than choosing taking; since choosing returning makes the reciprocal payoffs (or the product of kindness giving and perceiving) be positive but choosing taking makes the payoffs be negative.

Next, we will characterize the receiver's best response by applying the equilibrium condition of the DK model (for detail see *sequential reciprocity equilibrium* in Dufwenberg and Kirchsteiger (2004)). The equilibrium conditions are as follows: i) decisions and beliefs are consistent (e.g. $z_1 = \beta_{21}$) and ii) the utility of in-equilibrium decision is weakly better than of other decisions. Precisely, the receiver's decision and beliefs $(z_2^*, \beta_{21}^*, \beta_{212}^*)$ constitutes the equilibrium if

$$\beta_{21}^* = z_1, z_2^* = \beta_{212}^*, u_2(z_1, z_2^* | \beta_{21}^*, \beta_{212}^*) \geq u_2(z_1, z_2 | \beta_{21}^*, \beta_{212}^*).$$

Since the receiver's decision node is active by the first player's continuing, we know that in equilibrium of the second player $z_1 = \beta_{21}^* = 0$. Then, from (4.3-2), choose taking T is the second player's best response if

$$u_2(0,1|0,1) \geq u_2(0,0|0,1)$$

$$\emptyset_2 \leq \frac{2}{d}$$

and vice versa for choosing returning R be the best response. Hence, we derive (4.1-2).

A.4. Relationship between Decision in Dictator Game and Reciprocity Parameter in DK Model

This section shows the relationship between the amount of points the dictator keeps for himself and positive reciprocity in DK model. As mentioned, intuitively, we consider a dictator who takes most of the total monetary payoffs for himself as being selfish and equivalent to having low reciprocity parameter in the DK model. Therefore, we will show that the dictator's decision of the amount of monetary payoffs for himself has negative relationship with the reciprocity parameter in the DK model.

In the study, in the dictator game a dictator makes a decision $z_1 \in [0,200]$ and $z_1 \in \mathbb{I}$ to keep z_1 amount for himself. Theoretically, the dictator chooses z_1 that gives him the highest utility. Precisely, according to the DK model, the dictator chooses z_1 that solves the following optimization problem (Problem A.4-1),

PROBLEM A.4-1: $\max_{z_1} u_1 = z_1 + \emptyset_1 \cdot (200 - z_1 - \varepsilon) \cdot (z_1 - \varepsilon)$
where ε is the equitable payoffs that we assume the payoff be equal for both players (e.g. the equitable payoffs are 100 monetary payoffs which is the half of the total amount).

Suppose z_1 be continuous (by mixed strategy). Let z_1^* solve Problem A.4-1, since ε is constant, then we get the first-order condition as,

$$\left.\frac{\partial u_1}{\partial z_1}\right|_{z_1 = z_1^*} = 1 + \emptyset_1(200 - 2z_1^*) = 0.$$

Then, re-arranging the previous equation can show the negative relationship between the amount of monetary payoffs the dictator keeps for himself z_1^* and the reciprocity parameter $\emptyset_1$.[33]

[33] Also, it satisfies the second-order condition at z_1^*, $\left.\frac{\partial^2 u_1}{\partial z_1^2}\right|_{z_1 = z_1^*} = -2\emptyset_1 \leq 0$.

A.5. Regression Results of Personal-Info Method

This section presents the regression results of Personal-info method as presented in (4.4-6). The results are presented in Table A.5-1. ENN7 and ENN9 are the Enneagram of Personality type 7th and 9th respectively. SOCIAL is the agreement score (1-5) on personal activity related to social interaction. AGE is the age of subject. MUS is one if the subject's most favourite music type is not heavy metal, rock, pop, soundtrack, theme song, rap, hip hop nor alternative; and it is zero otherwise. SIB is the number of total siblings in the subject's family. PET is one if the subject had experience in raising any pet; and it is zero otherwise. BHUD is one if the subject is Buddhism; it is zero otherwise. EATPAY is amount of money the subject monthly pays on average. PENSION is amount of money the subject monthly pays on accommodation. DUMVOLREL is one if in the previous year the subject had experienced in being a volunteer on activity related to religious. SUBSIB is the order of subject among his total siblings.

Table A.5-1 Regression Results of Personal-Info Method.

	Scenario				
Variable	Z=2	Z=3	Z=4	Z=5	Z=6
Constant	4.55** (0.000)	0.80** (0.000)	1.34** (0.000)	0.98** (0.000)	1.24** (0.000)
ENN7	-0.66** (0.000)	-0.58** (0.000)	-0.35* (0.038)	-0.58** (0.000)	-
ENN9	0.37* (0.014)	-	-	-	-
SOCIAL	-	-	-	0.13** (0.006)	-
AGE	-0.12** (0.007)	-	-	-	-
MUS	-	-	-0.42** (0.006)	-	-
SIB	-0.24** (0.001)	-	-	-0.13** (0.000)	-
PET	-	-	-0.31* (0.034)	-	-
BHUD	-0.63* (0.038)	-	-	-	-
EATPAY	-	-	-0.0001** (0.000)	-	-
PENSION	-6.73×10^{-5}** (0.001)	-	-	-8.83×10^{-5}** (0.000)	-
DUMVOLREL	-	-	0.87** (0.000)	-	-
SUBSIB	-	-	-	-	-0.14** (0.000)
n	38	39	38	38	39
R^2	0.67	0.27	0.46	0.60	0.35

P-value shows in the parentheses. * Coefficient is significant at the 0.05 level (two-tailed). ** Coefficient is significant at the 0.01 level (two-tailed).

A.6. Experiment Materials: Advertisements, Instruction and Questionnaire

This section provides the experiment materials which include advertisements, instruction and questionnaire (all are in Thai).

Figure A.4-1 Contact Card

This card (in size 2"x3") provides the information about social network on internet and dates of each session of the experiment.

Figure A.4-2 The 1st Advertisement

This advertisement provides information about characteristics of subject who can participate in this experiment.

Figure A.4-3 The 2nd Advertisement

This advertisement provides basic knowledge about economic experiment.

Figure A.4-4 The 3rd Advertisement

This advertisement provides dates of each session of the experiment and minimum-maximum payment.

These are the instruction which was distributed for participants before each session would start. It explains general rules and regulations, period of the session, payments, etc. It ends where a participant signs his consent.

ข้อพึงปฏิบัติในการทดลอง

ยินดีต้อนรับทุกท่าน ขณะนี้ท่านกำลังเป็นส่วนหนึ่งของการทดลองทางเศรษฐศาสตร์ในหัวข้อเกี่ยวกับการตัดสินใจ โดยการทดลองนี้ได้รับการสนับสนุนจาก หลักสูตรเศรษฐศาสตร์ดุษฎีบัณฑิต จุฬาลงกรณ์มหาวิทยาลัย

กรุณาอ่านข้อมูลโดยละเอียด และทำความเข้าใจ ไปตามลำดับทุกบรรทัด และรอในจุดที่มีคำแนะนำให้รอ

กรุณาเข้าห้องน้ำ และทำกิจธุระส่วนตัวให้เรียบร้อยก่อนเวลา เริ่มต้นการเก็บข้อมูล (16.15-18.00 น.)

ขอความร่วมมือ

ห้ามการสนทนา และการสื่อสารทุกรูปแบบ ทั้งกับผู้ร่วมการทดลองภายในห้อง หรือบุคคลอื่นภายนอก เนื่องจากการสื่อสารทุกรูปแบบอาจจะส่งผลต่อการตัดสินใจของท่านได้ เราต้องการการตัดสินใจจาก ความคิดส่วนบุคคลของท่านเป็นสำคัญ

กรุณาปิดเครื่องมือสื่อสาร เพื่อไม่เป็นการรบกวนตัวท่านเอง และผู้ร่วมการทดลองท่านอื่น

เนื่องจากทีมงานได้คำนึงถึงการจัดสภาวะที่มีความเป็นส่วนตัว และปกปิดการตัดสินใจทุกอย่างของท่านเป็นความลับจากบุคคลอื่น อย่านำข้อมูลใดๆ ภายในการทดลองนี้ออกเผยแพร่สู่บุคคลอื่น ไม่ว่าจะเป็นผู้ที่เข้าร่วมการทดลองหรือบุคคลภายนอกการทดลอง เพื่อผลประโยชน์ของท่านเอง และเนื่องจากการทดลองนี้จะมีการจัดขึ้นหลายครั้ง ซึ่งการรู้ข้อมูลเกี่ยวกับการทดลองก่อนเข้าร่วมจะมีผลต่อการตัดสินใจ ซึ่งทำให้เป็นการตัดสินใจที่แตกต่างจากสภาวะปกติ และอาจส่งผลต่อผลตอบแทนที่จะได้รับทั้งของตัวท่านเองและผู้อื่นด้วย

ข้อแนะนำ หากมีข้อสงสัยใดๆ หรือต้องการความช่วยเหลือ กรุณายกมือได้ตลอดเวลา ทีมงานจะเข้าให้การช่วยเหลือกับท่านเป็นการบุคคล ทางทีมงานยินดีให้ความช่วยเหลือทุกท่านตลอดเวลา และขอยืนยันว่าการช่วยเหลือจาก ทีมงานจะอยู่ภายในกรอบที่ไม่ทำให้เกิดความเสียหายต่อผลตอบแทนของผู้เข้าร่วมการทดลองท่านอื่น

รายละเอียดภาพรวมก่อนการทดลอง

ระยะเวลาในการทดลอง

ในการทดลองนี้ ท่านจะถูกร้องขอให้ทำการตัดสินใจในสถานการณ์จำลองหลายสถานการณ์ และรวมถึงตอบคำถาม และตอบแบบสอบถามในตอนท้าย ซึ่งจะใช้เวลาทั้งหมดโดยประมาณ 1ชั่วโมง 30 นาที ถึง 2 ชั่วโมง

ผลตอบแทน

ผลตอบแทนที่ท่านจะได้รับมาจากสองส่วน ประกอบด้วย ส่วนแรกเป็นจำนวนเงิน 50 บาท ซึ่งจะได้รับจากการที่ท่านกรอกแบบสอบถามครบถ้วน สมบูรณ์ โดยท่านจะได้รับเงินส่วนนี้ในวันที่เข้าร่วมการทดลองทันทีหลังจบการทดลองในวันนั้นๆ

ส่วนที่สองเป็นผลตอบที่ได้จากคะแนนสะสมจากการตัดสินใจ และตอบคำถาม โดย

การตัดสินใจในสถานการณ์ย่อย ผลตอบแทนในส่วนนี้ขึ้นอยู่กับการตัดสินใจของตัวท่านเองและการตัดสินใจของผู้เข้าร่วมการทดลองท่านอื่น ที่จะถูกจับคู่แบบสุ่มกับท่าน

การตอบคำถาม ผลตอบแทนในส่วนนี้ ขึ้นอยู่กับการตอบคำถามของท่านว่า ตอบได้ถูกต้องหรือไม่ (คำถามจะมีข้อเฉลยชัดเจน)

ดังนั้นขอความร่วมมือในการทำความเข้าใจในสถานการณ์ และพิจารณาตัดสินใจอย่างถ้วนถี่ เพราะการตัดสินใจของท่าน มีผลต่อผลตอบแทนทั้งของท่านและของผู้อื่น

หน่วยของแต้มสะสมในการทดลองนี้ ใช้เป็นหน่วยชื่อ "Game Point" ย่อว่า "GP" ซึ่งในการทดลองนี้ได้กำหนดอัตราแลกเปลี่ยนระหว่าง GP : บาท เป็น

1 GP = 0.08 บาท

ทางทีมงานจะติดต่อให้ท่านมารับผลตอบแทนที่เหลือในภายหลัง ผ่านทางข้อมูลที่ท่านได้ระบุในแบบสอบถาม

สภาวะแวดล้อมในการทดลอง

1. ความเป็นส่วนตัว - ผู้เข้าร่วมการทดลองจะได้รับการดูแลในเรื่องของความเป็นส่วนตัวในการให้ข้อมูลตลอดการเข้าร่วมการทดลอง เพื่อเปิดโอกาสให้ผู้เข้าร่วมการทดลองได้มีอิสระในการตัดสินใจได้อย่างเต็มที่

2. การเก็บข้อมูลเป็นความลับ - ทางทีมงานได้ออกแบบรูปแบบการทดลองนี้ เพื่อให้ข้อมูลทุกอย่างของท่านเป็นความลับต่อทั้งบุคคลผู้เข้าร่วมการทดลอง และบุคคลภายนอก

3. จับคู่แบบสุ่ม - เนื่องจากสถานการณ์จำลอง เป็นสถานการณ์ที่ต้องใช้บุคคล 2 คนในการติดสินใจ และจะมีผู้ได้รับผลตอบแทน 2 คนต่อสถานการณ์ ทางทีมงานได้ใช้วิธีการจับคู่แบบสุ่ม โดยท่านจะถูกจับคู่กับ 1 ในผู้เข้าร่วมการทดลองทั้งจากการทดลองนี้หรือการทดลองครั้งอื่น (ซึ่งมีทั้งหมดมากกว่า 50 คน) เพื่อการคำนวณผลตอบแทนหนึ่งครั้ง และจะมีการจับคู่ใหม่ทุกครั้งที่มีการคำนวณผลตอบแทนใหม่

4. สมมติให้เป็นในทุกบทบาท - ในสถานการณ์ที่ต้องการการตัดสินใจของบุคคล 2 คน ท่านจะถูกสมมติให้ตัดสินใจทั้งในฐานะที่เป็น "บุคคลที่ 1" และ "บุคคลที่ 2" เพื่อให้ทุกท่านที่เข้าร่วมได้มีโอกาสในการตัดสินใจอย่างเท่าเทียมกัน

ช่องทางติดต่อกับทีมงาน และติดตามข่าวสาร

ผู้เข้าร่วมการทดลองทุกท่านสามารถติดต่อกับทีมวิจัย รวมถึงติดตามข่าวสารต่างๆ ผ่านทาง Facebook โดยสามารถเข้าไปกด like ได้ที่

Economic Experiment Club, Chulalongkorn University, Thailand

ท่านสามารถติดต่อขอนามบัตร Club ของเราได้จากเจ้าหน้าที่ทุกท่าน

กรุณาอ่านข้อมูลก่อนเข้าร่วมการทดลองให้ละเอียดครบถ้วน หากสงสัยกรุณาเรียกเจ้าหน้าที่เพื่อสอบถาม

หากท่านได้รับข้อมูลเบื้องต้นแล้ว และยินดีที่จะเข้าร่วมการทดลอง กรุณาเซ็นต์ชื่อในพื้นที่ด้านล่างด้วย

ข้าพเจ้าได้รับข้อมูลก่อนการทดลอง ตามเอกสารนี้ และยินดีให้ความร่วมมือในการทดลอง

(กรุณาเซ็นต์ชื่อในกรอบสี่เหลี่ยม)

This instruction explains how to make decisions in the dictator game and how to calculate the payment.

<u>คำอธิบายสถานการณ์ที่ 1</u>

ในสถานการณ์นี้ เป็นสถานการณ์จำลองของการ**ตัดสินใจของบุคคล 1 คน แต่มีบุคคล 2 คนที่จะได้รับค่าตอบแทน** โดย "บุคคลที่ 1" ทำการตัดสินใจ และได้รับผลตอบแทน และ "บุคคลที่ 2" ไม่มีสิทธิทำการตัดสินใจ แต่จะได้รับผลตอบแทนจากการตัดสินใจของบุคคลที่ 1 โดยในสถานการณ์นี้ <u>คุณจะได้รับบทบาทเป็นบุคคลที่ 1</u> และได้รับผลตอบแทนตามที่ตอบ

<u>ตัวอย่างคำถาม</u>

บุคคลที่ 1 มีสิทธิในการแบ่ง GP จากทั้งหมด 10 GP โดยแบ่งให้กับตัวเอง (เป็นจำนวนเต็มตั้งแต่ 0 ถึง 10 GP) และส่วนที่เหลือบุคคลที่ 2 จะได้รับไป

1. ให้คุณเป็นบุคคลที่ 1 คุณจะแบ่งให้ตัวเองเท่าไหร่? (ตอบเป็นจำนวนเต็มตั้งแต่ 0,1,2,…,10 GP)

ตอบ..

2. เพราะฉะนั้น บุคคลที่ 2 จะได้รับเท่าไหร่?

ตอบ...

<u>ตัวอย่างการตอบคำถาม</u>

ในสถานการณ์นี้ ในคำถามแรก<u>ให้คุณเติมจำนวน GP ที่คุณต้องการแบ่งให้ตัวเองลงไป</u> และ<u>เติม GP ส่วนที่เหลือที่บุคคลที่ 2 จะได้รับให้ถูกต้อง</u>

เช่น

1. ให้คุณเป็นบุคคลที่ 1 คุณจะแบ่งให้ตัวเองเท่าไหร่? (ตอบเป็นจำนวนเต็มตั้งแต่ 0,1,2,…,10 GP)

ตอบ............**8**.................................

2. เพราะฉะนั้น บุคคลที่ 2 จะได้รับเท่าไหร่?

ตอบ............**2**...................................

<u>การคำนวณผลตอบแทน</u>

ในการคำนวณผลตอบแทนของสถานการณ์นี้ **ทางทีมงานจะจับคู่คุณกับผู้เข้าร่วมการทดลองอีกคน** จากทั้งที่เข้าร่วมในการทดลองนี้และเข้าร่วมในการทดลองครั้งอื่น (จะมีทั้งหมดมากกว่า 50 คน) โดยเป็นการ **จับคู่แบบสุ่ม** โดย **คุณจะได้รับบทบาทเป็นบุคคลที่ 1 และอีกคนที่มาจากการสุ่มจะเป็นบุคคลที่ 2**

และการจับคู่เพื่อคำนวนผลตอบแทนนี้ **จะกระทำหลังจากจบการทดลองแล้ว**

This instruction explains how to make decisions in the each trust game and how to calculate the payment. It ends where a participant answers some questions to check his understanding; the correct answer earns payment.

<u>คำอธิบายสถานการณ์ที่ 2</u>

สถานการณ์ชุดนี้ ประกอบด้วย 8 สถานการณ์ย่อย ซึ่งเป็นสถานการณ์จำลองของการ**ตัดสินใจเป็นลำดับของบุคคล 2 คน** โดย "บุคคลที่ 1" ทำการตัดสินใจก่อน และ "บุคคลที่ 2" ทำการตัดสินใจหลังจากได้รู้การตัดสินใจของบุคคลที่ 1 แล้ว การตัดสินใจของทั้งสองคนจะมีผลต่อค่าตอบแทนที่แต่ละบุคคลจะได้รับไปจากการทดลองนี้

ใน 8 สถานการณ์ย่อยนี้ ได้ถูก**แบ่งออกเป็น 4 ชุด (ชุดละ 2 สถานการณ์ย่อย)** โดยทางทีมงานได้จัดเรียงแต่ละชุดเป็นลำดับไว้ให้แล้ว

ให้หยิบ**ทำทีละชุด** และตรวจสอบให้แน่ใจว่าไม่มีอะไรแก้ไขในชุดนั้นๆ ก่อนที่จะเริ่มต้นทำชุดใหม่

เมื่อเริ่มต้นทำชุดใหม่แล้ว **จะไม่อนุญาตให้กลับไปทำการแก้ไขการตัดสินใจในชุดที่ได้ทำไปแล้ว**

หลังจากได้ตอบคำถามในแต่ละสถานการณ์ย่อยแล้ว **ในสถานการณ์ย่อยใหม่ที่เกิดขึ้นจะไม่มีความเชื่อมโยงใดๆ ทั้งสิ้นกับสถานการณ์ย่อยเก่า**

กรุณา**ตอบคำถามไปทีละสถานการณ์ย่อยตามลำดับที่ได้จัดไว้ให้** และกรุณา**อย่าพยายามเชื่อมโยงความสัมพันธ์ของแต่ละสถานการณ์**

<u>ตัวอย่างคำถาม</u>

ในสถานการณ์นี้ บุคคลที่ 1 ทำการตัดสินใจในการแบ่ง GP กับบุคคลที่ 2 โดยบุคคลที่ 1 มีทางเลือกดังนี้

ก. แบ่งให้ตัวเอง 10 GP และให้บุคคลที่ 2 เป็นจำนวนเงิน 20 GP และจบสถานการณ์

ข. ให้บุคคลที่ 2 ตัดสินใจ โดยตนเองยอมรับการตัดสินใจของบุคคลที่ 2 ในทุกกรณี

ถ้าหากบุคคลที่ 1 ได้ตัดสินใจข้อ "ข.ให้บุคคลที่ 2 ตัดสินใจ..." หลักจากที่บุคคลที่ 2 ได้ทราบว่าตัวเองต้องทำการตัดสินใจ บุคคลที่ 2 มีทางเลือกในการตัดสินใจดังนี้

a. แบ่งให้บุคคลที่หนึ่ง 15 GP และแบ่งให้ตัวเอง 25 GP แล้วจบสถานการณ์

b. แบ่งให้บุคคลที่หนึ่ง 20 GP และแบ่งให้ตัวเอง 15 GP แล้วจบสถานการณ์

1. ถ้าคุณเป็นบุคคลที่ 2 ในสถานการณ์นี้ หลังจากที่บุคคลที่ 1 ได้ตัดสินใจข้อ "ข.ให้บุคคลที่ 2 ตัดสินใจ..." คุณจะตัดสินใจอย่างไร?

ตัวเลือก	คุณได้ (หน่วย GP)	อีกคนได้ (หน่วย GP)
a.	25	15
b.	15	20

2. ถ้าคุณเป็นบุคคลที่ 1 ในสถานการณ์นี้ คุณจะตัดสินใจอย่างไร?

ตัวเลือก	คุณได้ (หน่วย GP)	อีกคนได้ (หน่วย GP)
ก.	10	20
ข.	ให้บุคคลที่ 2 ตัดสินใจ	

3. คุณคิดว่า ในสถานการณ์นี้ คนส่วนใหญ่ที่เป็นบุคคลที่ 2 หลังจากที่บุคคลที่ 1 ได้ตัดสินใจข้อ "ข.ให้บุคคลที่ 2 ตัดสินใจ..." จะตัดสินใจ " a. " กี่เปอร์เซ็นต์ ?

<u>ตอบ</u> จะมีคนตอบ " a. " เป็นจำนวน .... เปอร์เซ็นต์

4. คุณคิดว่า ในสถานการณ์นี้ คนส่วนใหญ่ที่เป็นบุคคลที่ 1 จะตัดสินใจ "ก." กี่เปอร์เซ็นต์ ?

<u>ตอบ</u> จะมีคนตอบ "ก." เป็นจำนวน ....เปอร์เซ็นต์

ตัวอย่างการตอบคำถาม

ในสถานการณ์นี้ คุณต้อง**ตอบคำถามทั้ง 4 ข้อ** โดย

ข้อ 1-2 เลือกเพียงข้อละ 1 ตัวเลือกเท่านั้น

และ **ข้อ 3-4 เติมจำนวนเต็มตั้งแต่ 0 ถึง 100 (0, 1, 2, …, 100)**

รวมถึงการ**ตัดสินใจในสถานะของบุคคลที่ 2 ให้คุณตอบตามความรู้สึกโดยสมมติว่าคุณได้รับการตัดสินใจ "ข.ให้บุคคลที่ 2 ตัดสินใจ..." จากบุคคลที่ 1 จริงๆ**

คุณสามารถทำเครื่องหมายวงกลม หรือกากบาท ลงไปที่ตัวเลือกที่ต้องการจะเลือกได้เลย เช่น

ตัวเลือก	คุณได้ (หน่วย GP)	อีกคนได้ (หน่วย GP)
ก.	10	20
ข.	ให้บุคคลที่ 2 ตัดสินใจ	

การคำนวณผลตอบแทน

ในการคำนวณผลตอบแทนของสถานการณ์นี้ **ทางทีมงานจะจับคู่คุณกับผู้เข้าร่วมการทดลองอีกคน** จากทั้งที่เข้าร่วมในการทดลองนี้และเข้าร่วมในการทดลองครั้งอื่น (จะมีทั้งหมดมากกว่า 50 คน) โดยเป็นการ **จับคู่แบบสุ่ม** คุณจะ**ถูกจับคู่ 2 ครั้งต่อหนึ่งสถานการณ์** โดย

ครั้งแรกคุณจะได้รับบทบาทเป็นบุคคลที่ 1 และคู่ของคุณเป็นบุคคลที่ 2 และ

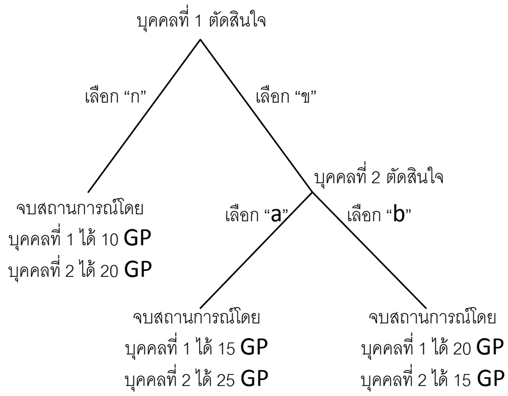
ครั้งที่สองคุณจะได้รับบทบาทเป็นบุคคลที่ 2 และคู่ของคุณเป็นบุคคลที่ 1

โดยจะ **ใช้เฉพาะคำตอบในคำถามข้อ 1 และ 2 เท่านั้น** ส่วนคำถามข้อที่ 3 และ 4 นั้นจะไม่มีการนำมาใช้คำนวณผลตอบแทน

โดยการจับคู่จะกระทำหลังจากจบการทดลองแล้ว

ตัวอย่างการคำนวณผลตอบแทน

เพื่อความง่าย ในสถานการณ์นี้สามารถถูกเปลี่ยนเป็นแผนภาพดังรูปด้านล่าง



สมมติว่ามีผู้เข้าร่วม 3 คน คือ "สมชาย", "สมศรี", และ "มาลี" โดยแต่ละคนได้ตัดสินใจในสถานการณ์นี้ คือ

สมชาย ตอบ ก., a.   สมศรี ตอบ ก., b.   มาลี ตอบ ข., b.

ดังนั้นถ้าสมมติว่าการจับคู่ที่เกิดขึ้นคือ

ในการจับคู่ครั้งที่ 1 สมชายเป็นบุคคลที่ 1 และสมศรีเป็นบุคคลที่ 2

สมชายจะได้ผลตอบแทนเป็นจำนวนเงิน ....10........ GP

และสมศรีจะได้ผลตอบแทนเป็นจำนวนเงิน ....20........ GP

ในการจับคู่ครั้งที่ 2 สมชายเป็นบุคคลที่ 2 และมาลีเป็นบุคคลที่ 1

สมชายจะได้ผลตอบแทนเป็นจำนวนเงิน ....25.......... GP

และมาลีจะได้ผลตอบแทนเป็นจำนวนเงิน ....15......... GP

เพราะฉะนั้น รวมผลตอบแทนจากสถานการณ์นี้

สมชายจะได้ผลตอบแทนรวมเป็นจำนวนเงิน ....35............ GP

กรุณาอ่านคำอธิบายสถานการณ์ที่ 2 ให้เข้าใจ

จะมีคำถามให้คำนวณผลตอบแทน ซึ่งผู้ที่ตอบได้ถูกต้องจะได้ 100 GP

ตอบคำถาม

ในส่วนที่นี้ จะเป็นคำถาม 7 ข้อ ซึ่ง

ข้อ 1 - 7 มีเฉลยที่ถูกหรือผิดชัดเจน ถ้าคุณตอบถูกคุณจะได้ข้อละ 25 GP

ส่วนนี้เราให้ท่านใช้เวลาทำ 15 นาที โดยเมื่อหมดเวลา เจ้าหน้าที่จะเก็บชุดคำถามนี้ทันที

หากท่านมีข้อสงสัยกรุณายกมือให้เจ้าหน้าที่ให้ความช่วยเหลือ

อย่ายกเอกสารขึ้นจากโต๊ะ หรือพูดคุย ให้สัญญาณใดๆ (ถ้าท่านทำผิดกฎจะขอพิจารณาไม่จ่ายผลตอบแทนรายบุคคล)

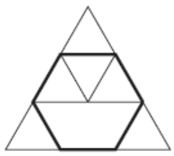
กรุณา รอ เพื่อให้เริ่มทำพร้อมกัน

This is the IQ test which has 7 questions.

1. ในรูปข้างล่างนี้ มีรูปวงกลมและสี่เหลี่ยมจตุรัสกี่รูป

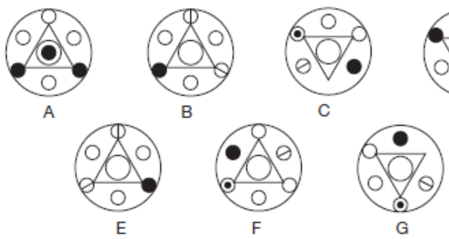
ตอบ...............................

2. ในรูปข้างล่างนี้ มีรูปทางเรขาคณิตอื่นๆ นอกจากสามเหลี่ยมและสีเหลี่ยมหรือไม่

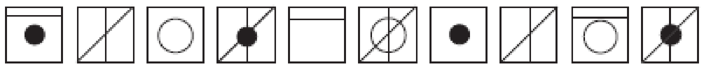


ตอบ.................................

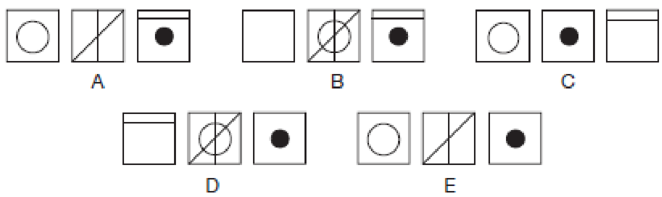
3. ภาพใดไม่เข้าพวก (วงกลมหรือกากบาท ตัวเลือก)



4. จากรูปด้านล่างนี้



รูปต่อไปคือข้อใด (วงกลมหรือกากบาทตัวเลือก)



5. ชุดตัวเลขถัดไปคืออะไร

3846721
4672183
7218364

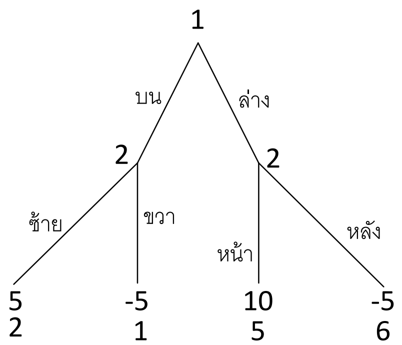
ตอบ: ……………………..

6. ตัวเลขที่ควรระบุแทนเครื่องหมาย ? ในรูปด้านล่าง คือตัวเลขอะไร

	1				2	1
	3		3	5		
3	4		5	5	4	
3		2		?		2
2					4	
3		3	3	4		2
2	3		3		2	

ตอบ..............................

7. รูปด้านล่างแสดงผลลัพธ์ของการตัดสินใจของผู้เล่นคนที่ 1 และผู้เล่นคนที่ 2 ในเกมส์ที่มีการตัดสินใจเป็นลำดับ การตัดสินใจในดุลยภาพ ผู้เล่นคนที่ 1 จะตัดสินใจอย่างไร?



ตอบ..............................

กรุณา<u>ตรวจสอบ</u>คำตอบ และ<u>รอ</u>เพื่อเริ่มต้นส่วนต่อไปพร้อมกัน

This is the questionnaire which composes of three-question enneagram-personality test, attitude test and socio-economics background.

คำแนะนำ

แบบสอบถามนี้ แบ่งออกเป็น 2 ส่วน รบกวนให้ท่านอ่านโดยละเอียด และให้ข้อมูลตามความเป็นจริงเกี่ยวกับตัวท่านมากที่สุด การทำแบบสอบถามนี้ **ไม่กำหนดเวลา** ท่านสามารถใช้เวลาทำได้เต็มที่ ทั้งนี้เฉพาะแบบสอบถามที่มีการตอบได้อย่างสมบูรณ์เท่านั้น ท่านจึงจะได้รับ **ค่าตอบแทนจากการทำแบบสอบถาม 50 บาท (และค่าตอบแทนจากการตัดสินใจในตอนต้นจะติดต่อให้มารับในภายหลัง)** โดยหากเสร็จเรียบร้อยแล้วกรุณายกมือ เพื่อให้เจ้าหน้าที่เข้าดำเนินการตามขั้นตอนต่อไปกับท่าน

รายละเอียดแบบสอบถามแต่ละส่วนมีดังนี้

ส่วนที่ 1 ประกอบด้วยคำถาม 20 ข้อ มีวัตถุประสงค์เพื่อวัดบุคลิกภาพ และทัศนคติ ของท่าน

ส่วนที่ 2 ประกอบด้วยคำถาม 16 ข้อ มีวัตถุประสงค์เพื่อรับทราบข้อมูลพื้นฐาน และความชอบบางอย่างของท่าน และในคำถามข้อที่ 15 จะมีผลต่อค่าตอบแทนที่ท่านจะได้รับไปจากการทดลองนี้

ในส่วนสุดท้าย เราได้ทิ้งที่ว่างไว้ให้ท่านเพื่อทำการเขียนข้อเสนอแนะ หรือความในใจใดๆ ก็ได้ให้ทางเราได้รับทราบ ข้อความของท่านจะเป็นประโยชน์อย่างยิ่งต่อเรา

กรุณาติดตามข่าวสารประชาสัมพันธ์ต่างๆ รวมถึงนัดรับค่าตอบแทนด้วยการกด "Like" ที่ FaceBook นี้

Economic Experiment Club, Chulalongkorn University, Thailand

ขอขอบพระคุณในความร่วมมือตลอดการทดลองมา ณ ที่นี้

กรภพ ภิรมย์ภักดี

ผู้ดำเนินการวิจัย

ส่วนที่ 1

คำแนะนำ: กรุณาวงกลมเลือก 1 ตัวเลือก ที่บ่งบอกความเป็นตัวคุณมากที่สุด

1. เลือกข้อที่ใกล้เคียงกับตัวเองที่สุด (วงกลม 1 ข้อ)

a. ฉันค่อนข้างจะรักอิสระมีความมั่นใจตนเอง รู้สึกว่าชีวิตจะมีรสชาติเมื่อได้ต่อสู้ ฉันกำหนดเป้าหมายของชีวิตด้วยตนเอง และลงมือกระทำเพื่อให้บังเกิดผล ฉันไม่ชอบนั่งคอยโชคชะตา ปรารถนาความสำเร็จอันยิ่งใหญ่ ไม่ชอบให้ใครบังคับ และไม่แสวงหาการเผชิญหน้าโดยไม่จำเป็น ฉันรู้ว่าฉันต้องการอะไรและกระทำเพื่อให้ได้มา มักจะทำงานหนัก และเล่นอย่างจริงจัง

b. ฉันค่อนข้างเป็นคนเงียบ มีโลกส่วนตัว ไม่ค่อยชอบออกสังคม รู้สึกไม่ค่อยสะดวกใจในการเป็นผู้นำและแข่งขันกับผู้อื่น หลายคนมักบอกว่าฉันเป็นคนช่างฝัน ปลุกเร้าด้วยจินตนาการ ฉันมีความพึงพอใจได้โดยไม่ต้องมีความรู้สึกกระตือรือร้นตลอดเวลา

c. ฉันค่อนข้างมีความรับผิดชอบและชอบอุทิศตัวอย่างสูง จะรู้สึกแย่มากเมื่อไม่สามารถรักษาคำมั่นสัญญาหรือสิ่งที่คนอื่นคาดหวังไว้ได้ ฉันอยากให้คนอื่นรู้ว่า ฉันอยู่ที่นั่นเพื่อเขา และจะทำในสิ่งที่คิดว่าดีที่สุดเพื่อเขา ฉันได้เสียสละเพื่อผู้อื่นอยู่บ่อยๆ ไม่ว่าเขาจะรู้ตัวหรือไม่ ฉันมักจะไม่ได้ดูแลตัวเองนัก ทำงานในสิ่งที่ต้องทำและพักผ่อนโดยทำในสิ่งที่อยากทำเมื่อมีเวลาเหลือ

2. เลือกข้อที่ใกล้เคียงกับตัวเองที่สุด (วงกลม 1 ข้อ)

a. ฉันเป็นคนที่มองโลกในแง่ดี รู้สึกว่าสิ่งต่างๆ ดำเนินไปได้ดีที่สุดแล้ว สนใจสิ่งต่างๆ รอบตัว ชอบอยู่ร่วมกับผู้คนและช่วยเขาให้มีความสุข ฉันพอใจที่จะแบ่งปันความสุขของฉันให้เขา จนบางครั้งฉันก็ละเลยการแก้ปัญหาของตนเอง

b. ฉันเป็นคนที่มีความรู้สึกรุนแรงต่อสิ่งต่างๆ ผู้คนมักจะรู้สึกถึงความกังวลไม่สบายใจของฉัน ฉันต้องการรู้ว่าฉันอยู่ร่วมกับคนอื่นในสถานะใด สิ่งใดหรือใครที่ฉันสามารถพึ่งพาได้ เมื่ออารมณ์เสีย ฉันต้องการให้คนอื่นตอบสนองและมีอารมณ์ร่วม ฉันรู้กฎแต่ไม่อยากให้ใครมาบอกว่าต้องทำนั่นทำนี่ ฉันอยากตัดสินใจด้วยตัวเอง

c. ฉันเป็นคนที่มักจะควบคุมตนเองและมีเหตุผล ไม่สะดวกใจกับการมีอารมณ์ความรู้สึก ฉันเป็นคนมีประสิทธิภาพ ชอบความสมบูรณ์แบบและชอบทำงานด้วยตนเอง เมื่อมีปัญหาและความขัดแย้ง ฉันจะพยายามไม่ใช้อารมณ์เข้าไปจัดการ บางคนจึงมักบอกว่าฉันเย็นชาและแยกตัว นั่นเพราะฉันไม่ต้องการให้อารมณ์ความรู้สึกมาทำให้เขวจากสิ่งที่สำคัญกว่า

คำแนะนำ: ข้อ 1-18 เป็นคำถามแบบตัวเลือก 4 ระดับ (1,2,3,4) กรุณาวงกลมเลือก 1 ตัวเลือก ที่บ่งบอกความเป็นตัวคุณมากที่สุด

1. "ถ้าฉันทำกระจกแตก มันคือลางร้าย" คุณเห็นด้วย มาก-น้อย เพียงใด

เห็นด้วยน้อย			เห็นด้วยมาก
1	2	3	4

2. "มันเป็นไปได้เสมอที่ฉันจะทำให้ชีวิตประสบความสำเร็จ" คุณเห็นด้วย มาก-น้อย เพียงใด

เห็นด้วยน้อย			เห็นด้วยมาก
1	2	3	4

3. "ฉันสามารถตัดสินใจได้อย่างถูกต้องเวลาที่เผชิญกับทางเลือกต่างๆ" คุณเห็นด้วย มาก-น้อย เพียงใด

เห็นด้วยน้อย			เห็นด้วยมาก
1	2	3	4

4. "เพื่อนของฉันจะไม่ทำให้ฉันเสียใจ" คุณเห็นด้วย มาก-น้อย เพียงใด

เห็นด้วยน้อย			เห็นด้วยมาก
1	2	3	4

5. "ทุกคนเกิดมาพร้อมกับเนื้อคู่ของตัวเอง" คุณเห็นด้วย มาก-น้อย เพียงใด

เห็นด้วยน้อย			เห็นด้วยมาก
1	2	3	4

6. "ฉันเป็นคนมีมุมมองชีวิตโดยทั่วไปที่ไม่เคร่งเครียด" คุณเห็นด้วย มาก-น้อย เพียงใด

เห็นด้วยน้อย			เห็นด้วยมาก
1	2	3	4

7. "ฉันชอบที่จะทำสิ่งต่างๆ ในเวลาและความต้องการของตัวเอง โดยไม่ยึดติดกับใคร" คุณเห็นด้วย มาก-น้อย เพียงใด

เห็นด้วยน้อย			เห็นด้วยมาก
1	2	3	4

8. "ฉันชอบวิจารณ์ผู้อื่น" คุณเห็นด้วย มาก-น้อย เพียงใด

เห็นด้วยน้อย			เห็นด้วยมาก
1	2	3	4

9. "การตรงต่อเวลาเป็นสิ่งสำคัญสำหรับฉัน" คุณเห็นด้วย มาก-น้อย เพียงใด

เห็นด้วยน้อย			เห็นด้วยมาก
1	2	3	4

10. "ฉันเป็นคนที่ตั้งเป้าหมายในชีวิตและพยายามไปให้ถึงจุดนั้น" คุณเห็นด้วย มาก-น้อย เพียงใด

เห็นด้วยน้อย			เห็นด้วยมาก
1	2	3	4

11. "ถ้าฉันทำข้อสอบไม่ได้เลย จนมั่นใจว่าคุณจะต้องตกได้ F แน่ๆ ในวิชานั้น และฉันมั่นใจว่าเพื่อนที่นั่งข้างๆ ซึ่งเก่งวิชานี้เขาสามารถทำได้ และอนุญาตให้คุณลอกคำตอบ ณ วินาทีที่ฉันมั่นใจว่า ฉันสามารถลอกคำตอบได้โดยที่ไม่ถูกจับ ฉันจะลอกคำตอบ" คุณเห็นด้วย มาก-น้อย เพียงใด

เห็นด้วยน้อย			เห็นด้วยมาก
1	2	3	4

12. "การทำบุญจะทำให้ฉันได้รับสิ่งที่ดีตอบแทน" คุณเห็นด้วย มาก-น้อย เพียงใด

เห็นด้วยน้อย			เห็นด้วยมาก
1	2	3	4

13. "ถ้าใครทำสิ่งดีๆ ให้กับฉัน ฉันจะพยายามหาทางตอบแทนเขา" คุณเห็นด้วย มาก-น้อย เพียงใด

เห็นด้วยน้อย			เห็นด้วยมาก
1	2	3	4

14. "คนส่วนใหญ่ในสังคม ที่ทำดีกับฉัน เพราะคาดหวังให้ฉันทำดีกลับ" คุณเห็นด้วย มาก-น้อย เพียงใด

เห็นด้วยน้อย			เห็นด้วยมาก
1	2	3	4

15. "ฉันมีคนที่รัก และพร้อมจะทำดีให้โดยไม่หวังผลตอบแทน" คุณเห็นด้วย มาก-น้อย เพียงใด

เห็นด้วยน้อย			เห็นด้วยมาก
1	2	3	4

16. "หากมีคนแปลกหน้าจะมาขอความช่วยเหลือ ฉันพร้อมที่จะรับฟังและให้การช่วยเหลืออย่างเต็มที่หากทำได้" คุณเห็นด้วย มาก-น้อย เพียงใด

เห็นด้วยน้อย			เห็นด้วยมาก
1	2	3	4

17. "ศาสนามีความสำคัญกับฉัน" คุณเห็นด้วย มาก-น้อย เพียงใด

เห็นด้วยน้อย			เห็นด้วยมาก
1	2	3	4

18. "ฉันชอบใช้เวลาวันๆ นึงไปกับกิจกรรมทางสังคม เช่น พูดคุย พบปะสังสรรค์ แลกเปลี่ยนสิ่งต่างๆ ใน Social network และอื่นๆ" คุณเห็นด้วย มาก-น้อย เพียงใด

เห็นด้วยน้อย			เห็นด้วยมาก
1	2	3	4

ส่วนที่ 2

คำแนะนำ: ทำเครื่องหมาย หรือระบุ ข้อมูลตามความเป็นจริงของท่าน

อายุ (ระบุ): ....

เพศ: ....ชาย ....หญิง

ศาสนา: ....พุทธ ....คริสต์ ....อิสลาม อื่นๆ(ระบุ)................

สาขาที่จบระดับมัธยมปลาย: ....วิทย์ ....ศิลป์-คำนวณ ....ศิลป์-ภาษา อื่นๆ(ระบุ)..................

สาขาที่กำลังศึกษา(ระบุ):..

ระดับ-ชั้นปี(ระบุ):..

คุณทำงานพิเศษหรืองานประจำด้วยหรือไม่: ....ทำ ....ไม่ได้ทำ

1. คุณมีรายได้ต่อเดือนเป็นจำนวน .... บาท/เดือน

โดยได้รับจาก พ่อ-แม่ เป็นจำนวน .... บาท/เดือน

ทุนการศึกษาหรือแหล่งรายได้ที่ไม่ต้องทำงานอื่นๆ .... บาท/เดือน

รายได้จากการทำงาน .... บาท/เดือน

โดยมีรายจ่ายเป็น ค่าที่อยู่อาศัย(กรณีอยู่หอพัก) .... บาท/เดือน

ค่ากินอยู่และค่าใช้จ่ายจำเป็น .... บาท/เดือน

ค่าเดินทาง ไป+กลับ จากที่พักถึงมหาวิทยาลัย .... บาท/เดือน

ค่าใช้จ่ายฟุ่มเฟือยเพื่อความบันเทิงและความสุข .... บาท/เดือน

เงินออม .... บาท/เดือน

2. คุณมีพี่น้อง(รวมตัวเอง)จำนวน .... คน และคุณเป็นคนที่ ....

3. คุณชอบเล่นกีฬาแบบประเภทใดมากที่สุด

....ประเภททีมหลายคน 2 คน เช่น ฟุตบอล วอลเล่บอล บาสเกตบอล

....ประเภทบุคคลหรือเป็นทีมเล็กๆ เช่น ฟิตเนส ว่ายน้ำ เทนนิส แบดมินตัน ปิงปอง

4. สไตล์เพลงที่คุณชอบฟังมากที่สุด 3 ลำดับ (1=ชอบมากที่สุด และน้อยลงตามลำดับ)

....ประเภทที่ 1 - Soul, Funk, Dance, Electronica, Folk

....ประเภทที่ 2 - Classical, Blues, Jazz

....ประเภทที่ 3 - Heavy metal, Rock

....ประเภทที่ 4 - Pop, Soundtrack, Theme song

....ประเภทที่ 5 - Rap, Hip Hop, Alternative

....ประเภทที่ 6 - Religious

5. ในช่วง 1 ปีที่ผ่านมา คุณเคยทำงานอาสาสมัครเพื่อช่วยเหลือสังคมหรือไม่

....เคย(ระบุกิจกรรมที่เคยทำสั้นๆ)...

....ไม่เคย

6. ในช่วง 1 ปีที่ผ่านมา คุณเคยทำงานในระดับผู้นำ เช่น หัวหน้ากิจกรรมสำคัญต่างๆ หรือไม่

....เคย(ระบุกิจกรรมที่เคยทำสั้นๆ)..

....ไม่เคย

7. คุณ เลี้ยงหรือเคยเลี้ยง สัตว์ที่ทำให้คุณรู้สึกผูกพันธ์มากๆ หรือไม่

....เคย(ระบุชนิดสัตว์ดังกล่าว)..

....ไม่เคย

8. คุณ มีหรือเคยมี ภาระที่ต้องให้การดูแลบุคคลอย่างใกล้ชิดสม่ำเสมอ เช่น ผู้ชราในครอบครัว บ้างหรือไม่

....เคย บุคคลเหล่านั้นมีความสัมพันธ์กับคุณอย่างไร(ระบุ)..............................

....ไม่เคย

9. ค่าตอบแทนที่คุณจะได้รับจากการเข้าร่วมการทดลองนี้ คุณมีความประสงค์จะทำบุญเท่าไหร่?

ตอบ (ระบุจำนวน 0 - 100 เปอร์เซ็นต์)..

*** คำตอบในข้อ 15 จะนำไปทำการหักค่าตอบแทนส่วนนึงเพื่อนำไปทำบุญตามที่ท่านได้ระบุ

เช่น หากท่านระบุ 70 เปอร์เซ็นต์ สมมติว่าหลังจากคำนวณ GP ของท่านทั้งหมดและเปลี่ยนเป็นหน่วยเงินบาทแล้ว ท่านได้ 200 บาท ดังนั้นเราจะหัก 140 บาท (= 70 เปอร์เซ็นต์ของ 200 บาท) นำไปทำบุญและนำค่าตอบแทนให้กับท่าน 60 บาท ***

10. กรุณาระบุชื่อ และรายละเอียดเพื่อใช้ในการติดต่อรับผลตอบแทนจากการเข้าร่วมซึ่งจะติดต่อให้มารับในภายหลัง

ชื่อ...

เบอร์ติดต่อ.. อีเมล..

FaceBook(อีเมลหรือชื่อที่ใช้ search ได้):...

APPENDIX B

B.1. Proof of Proposition 6.2-1

The proof directly shows that playing the equilibrium strategy is better than playing other out-of-equilibrium strategy. According to the equilibrium strategy, in the case of high type realization, t_h, playing the equilibrium strategy $s^S(t_h) = \left(\rho^S(t_h), b^S(t_h)\right)$ yields the bidder *i* 0.5 probability that he pays $W(t_h) - L(t_h)$ and obtains the object (which yields him $W(t_h)$ payoff) and 0.5 probability that he pays nothing and his opponent obtains it (which yields the bidder *i* $L(t_h)$ payoff). Hence, the bidder *i*'s expected utility is

$$u_{i,t_h}\left(s_i^S(t_h) \middle| s_j^S(t_h)\right) = L(t_h),$$

where $s_i^S(t_h)$ is the bidder i playing the high-type equilibrium strategy. Deviating to other strategy $(\rho_i, b_i) \neq s^S(t_h)$ is not better. To see this, not participating, participating with $b_i \neq W(t_h) - L(t_h)$ (given bidder *j* strictly plays the equilibrium strategy) yields him $L(t_h)$ payoff. Hence, we finish showing that $s^S(t_h)$ is the symmetric-equilibrium strategy for high type realization.

Next, in the case of low type realization, t_l, we show by similar arguments. Playing the equilibrium strategy $s^S(t_l) = \left(\rho^S(t_l), b^S(t_l)\right)$ yields $\left(\frac{2W(t_l)}{W(t_l)+L(t_l)}\right)^2$, $2\left(\frac{2W(t_l)}{W(t_l)+L(t_l)}\right)\left(\frac{L(t_l)-W(t_l)}{W(t_l)+L(t_l)}\right)$ and $\left(\frac{L(t_l)-W(t_l)}{W(t_l)+L(t_l)}\right)^2$ probability that both bidders participate, only one bidder participates and nobody participates respectively. If both participate, the bidder *i* has 0.5 chance of paying nothing and being obtainer (which yields him $W(t_l)$ payoff) and 0.5 chance of paying nothing and his opponent being obtainer (which yields him $L(t_l)$ payoff). If the bidder *i* participates but his opponent does not, he obtains the object without payment. If his opponent participates but he does not, his opponent obtains it and he pays nothing. And, if both do not participate, the seller keeps the object (which yields each bidder 0 payoff and pays nothing). Hence, the bidder *i*'s expected utility is

$$u_{i,t_l}\left(s_i^S(t_l) \middle| s_j^S(t_l)\right) = \frac{2W(t_l)}{W(t_l) + L(t_l)}.$$

Deviating to other strategy $(\rho_i, b_i) \neq s^S(t_l)$ is not better. To see this, since $\frac{2W(t_l)}{W(t_l)+L(t_l)} > W(t_l)$, submitting $b_i > 0$ yields him $W(t_l)$ payoff which is worse; playing $\rho_i = \left(\frac{2W(t_l)}{W(t_l)+L(t_l)} + \varepsilon\right)P + \left(\frac{L(t_l)-W(t_l)}{W(t_l)+L(t_l)} - \varepsilon\right)N$ for some $\varepsilon \neq 0$ yields him $\frac{2W(t_l)}{W(t_l)+L(t_l)}$. Hence, we finish showing that $s^S(t_l)$ is the symmetric-equilibrium strategy for low type realization. And we finish the proof.

Q.E.D.

B.2. Proof of Proposition 6.2-2

To prove the proposition, we show that playing the equilibrium strategy is better than deviating to other strategies. If both bidders play the equilibrium strategy, expected utility of bidder i is derived into three piecewises: when the bidder has $t_i \in [\underline{t}, \tilde{t})$, $t_i \in [\tilde{t}, t')$ and $t_i \in [t', \bar{t}]$. When the bidder has $t_i \in [\underline{t}, \tilde{t})$, he does not participate; hence, with $1 - F(\tilde{t})$ chance, his opponent participates and obtains the object (which yields the bidder i $L(t_i)$ payoff). When the bidder has $t_i \in [\tilde{t}, t')$, he participates with zero bid; hence with $F(\tilde{t})$, $F(t') - F(\tilde{t})$ and $1 - F(t')$ that his opponent does not participate (which yields the bidder i $W(t_i)$ payoff), participates with zero bid (which yields the bidder i $\frac{1}{2}\big(W(t_i) + L(t_i)\big)$ payoff) and participates with $W(t_j) - L(t_j)$ bid (which yields the bidder i $L(t_i)$ payoff) respectively. Last, when the bidder has $t_i \in [t', \bar{t}]$, he participates with $W(t_i) - L(t_i)$ bid; hence with $1 - F(t')$, $F(t_i) - F(t')$ and $1 - F(t_i)$ chance that he obtains the object without payment, obtains it with $W(t_j) - L(t_j)$ payment and his opponent obtains it, respectively. The bidder i's expected utility is presented as follows:

$$u_i^*(t_i) = u_i\big(t_i, s_i^S(t_i)\big|s_j^S\big)$$
$$= \begin{cases} \int_{\tilde{t}}^{\bar{t}} L(t_i)dF(t) \ for\ t_i \in [\underline{t}, \tilde{t}) \\ \int_{\underline{t}}^{\tilde{t}} W(t_i)dF(t) + \int_{\tilde{t}}^{t'} \frac{1}{2}\big(W(t_i) + L(t_i)\big)dF(t) + \int_{t'}^{\bar{t}} L(t_i)dF(t) \ for\ t_i \in [\tilde{t}, t') \\ \int_{\underline{t}}^{t'} W(t_i)dF(t) + \int_{t'}^{t_i} \big(W(t_i) - W(t) + L(t)\big)dF(t) + \int_{t_i}^{\bar{t}} L(t_i)dF(t) \ for\ t_i \in [t', \bar{t}] \end{cases},$$

where $s_i^S(t_i)$ is the bidder i playing the equilibrium strategy of corresponding type.

Then, we check that deviating to other non-equilibrium strategy is weakly worse than not deviating. According to the expected utility, we check three cases: deviation when $t_i \in [\underline{t}, \tilde{t})$, when $t_i \in [\tilde{t}, t')$ and when $t_i \in [t', \bar{t}]$. If the deviation is weakly

Case 1: deviation when $\boldsymbol{t_i \in [\underline{t}, \tilde{t})}$

In this case, $s_i^S(t_i) = (N, 0)$. We check that when $(\rho_i, b_i) \neq s_i^S(t_i)$ is not better. Suppose $\rho_i = P$, it is best to submit with bid $b_i = 0$; hence, with $F(\tilde{t})$, $F(t') - F(\tilde{t})$ and $1 - F(t')$ chance that his opponent does not participate (which yields the bidder i $W(t_i)$ payoff), participates with zero bid (which yields the bidder i $\frac{1}{2}\big(W(t_i) + L(t_i)\big)$ payoff) and participates with positive bid (which yields the bidder i $L(t_i)$ payoff), respectively. Hence, the expected utility is

$$u_i\big(t_i, (P, 0)\big|s_j^S\big) = \int_{\underline{t}}^{\tilde{t}} W(t_i)dF(t) + \int_{\tilde{t}}^{t'} \frac{1}{2}\big(W(t_i) + L(t_i)\big)dF(t) + \int_{t'}^{\bar{t}} L(t_i)dF(t).$$

By comparing the utility get between in-equilibrium and out-of-equilibrium strategies,

$$\Delta^1(t_i) = u_i^*(t_i) - u_i\big(t_i, (P,0)\big|\big(\rho_j^S, b_j^S\big)\big)$$
$$= -\int_{\underline{t}}^{\tilde{t}} W(t_i)dF(t) - \int_{\tilde{t}}^{t'} \frac{1}{2}\big(W(t_i) - L(t_i)\big)dF(t).$$

Next, we need to show that $\Delta^1(t_i) \geq 0$ for $\forall t_i \in \big[\underline{t}, \tilde{t}\big)$. We know that $\Delta^1\big(\underline{t}\big) > 0$ and $\frac{d\Delta^1(t_i)}{dt_i} < 0$. According to (6.2-1), $\Delta^1(\tilde{t}) = 0$. Hence, we finish showing that $\Delta^1(t_i) \geq 0$ for $\forall t_i \in \big[\underline{t}, \tilde{t}\big)$ and finish showing that $(N, 0)$ is the equilibrium strategy when $t_i \in \big[\underline{t}, \tilde{t}\big)$.

Case 2: deviation when $\mathbf{t_i} \in [\tilde{\mathbf{t}}, \mathbf{t}')$

In this case, $s_i^S(t_i) = (P, 0)$. Similarly, we check that when $(\rho_i, b_i) \neq s_i^S(t_i)$ is not better. Suppose $b_i \neq 0$ and $\rho_i = P$, he gets less than playing the equilibrium strategy. Suppose $\rho_i = N$, regardless of b_i, he gets $\int_{\tilde{t}}^{\bar{t}} L(t_i)dF(t)$. By comparing the expected utility,

$$\Delta^2(t_i) = u_i^*(t_i) - u_i\big(t_i, (N, b_i)\big|\big(\rho_j^S, b_j^S\big)\big) = \int_{\underline{t}}^{\tilde{t}} W(t_i)dF(t) + \int_{\tilde{t}}^{t'} \frac{1}{2}\big(W(t_i) - L(t_i)\big)dF(t).$$

Next, we need to show that $\Delta^2(t_i) \geq 0$ for $\forall t_i \in [\tilde{t}, t')$. We know that $\Delta^2(t') > 0$ and $\frac{d\Delta^2(t_i)}{dt_i} > 0$. According to (6.2-1), $\Delta^2(\tilde{t}) = 0$. Hence, we finish showing that $\Delta^2(t_i) \geq 0$ for $\forall t_i \in [\tilde{t}, t')$ and finish showing that $(N, 0)$ is the equilibrium strategy when $t_i \in \big[\underline{t}, \tilde{t}\big)$.

Case 3: deviation when $\mathbf{t_i} \in \big[\mathbf{t}', \bar{\mathbf{t}}\big]$

In this case, $s_i^S(t_i) = \big(P, W(t_i) - L(t_i)\big)$. Similarly, we check that when $(\rho_i, b_i) \neq s_i^S(t_i)$ is not better. Suppose $\rho_i = N$, regardless of b_i, he gets $\int_{\tilde{t}}^{\bar{t}} L(t_i)dF(t)$ which is less than playing the equilibrium strategy. Suppose $b_i \neq W(t_i) - L(t_i)$ and $\rho_i = P$, he also gets less than playing the equilibrium strategy. Hence, we finish the proof.

Q.E.D.

B.3. Proof of Proposition 6.3-1

The proof directly shows that playing the equilibrium strategy is better than playing other out-of-equilibrium strategy. According to the equilibrium strategy, in the case of high type realization, t_h, playing the equilibrium strategy $s^{TG}(t_h) = \big(\rho^{TG}(t_h), b^{TG}(t_h), d^{TG}(t_h)\big)$ yields the bidder *i* 0.5 probability that he pays $W(t_h) - L(t_h)$ and obtains the object (which yields him $W(t_h)$ payoff) and 0.5 probability that he pays nothing and his opponent obtains it (which yields the bidder *i* $L(t_h)$ payoff). Hence, the bidder *i*'s expected utility is

$$u_{i,t_h}\big(s_i^{TG}(t_h)\big|s_j^{TG}(t_h)\big) = L(t_h),$$

where $s_i^{TG}(t_h)$ is the bidder *i* playing the high-type equilibrium strategy. Deviating to other strategy $(\rho_i, b_i, d_i) \neq s^{TG}(t_h)$ is not better. To see this, (given bidder *j* strictly plays the equilibrium strategy) $d_i = give$ yields him at most $L(t_h)$ payoff which is not better; $\rho_i = N$

or $b_i \neq W(t_h) - L(t_h)$ also yields him at most $L(t_h)$ payoff. Hence, we finish showing that $s^{TG}(t_h)$ is the symmetric-equilibrium strategy for high type realization.

By showing similar arguments, we can prove that $(P, L(t_l) - W(t_l), give)$ is the symmetric-equilibrium strategy for low type realization, t_l. We finish the proof.

Q.E.D.

B.4. Proof of Proposition 6.3-2

To prove the proposition, we show that playing the equilibrium strategy is better than deviating to other strategies. If both bidders play the equilibrium strategy, expected utility of bidder *i* is derived into two piecewises: when the bidder has $t_i \in [\underline{t}, t')$ and $t_i \in [t', \bar{t}]$. When the bidder has $t_i \in [\underline{t}, t')$, he participates with $L(t_i) - W(t_i)$ bid and demand to give; hence, with $F(t_i)$, $F(t') - F(t_i)$ and $1 - F(t')$ chance that he receives (from his opponent) the object without payment, gives it with $L(t_j) - W(t_j)$ payment and gives it without payment (since the opponent demands to take). Similarly, we can derive the expected utility when the bidder has $t_i \in [t', \bar{t}]$. The bidder *i*'s expected utility is presented as follows:

$$u_i^*(t_i) = u_i\big(t_i, s_i^{TG}(t_i)\big|s_j^{TG}\big)$$
$$= \begin{cases} \int_{\underline{t}}^{t_i} W(t_i)dF(t) + \int_{t_i}^{t'} \big(L(t_i) - L(t) + W(t)\big)dF(t) + \int_{t'}^{\bar{t}} L(t_i)dF(t) \ for\ t_i \in [\underline{t}, t') \\ \int_{\underline{t}}^{t'} W(t_i)dF(t) + \int_{t'}^{t_i} \big(W(t_i) - W(t) + L(t)\big)dF(t) + \int_{t_i}^{\bar{t}} L(t_i)dF(t) \ for\ t_i \in [t', \bar{t}] \end{cases},$$

where $s_i^{TG}(t_i) = \big(\rho^{TG}, b^{TG}(t_i), d^{TG}(t_i)\big)$ is the bidder i playing the equilibrium strategy of corresponding type.

Then, we check that deviating to other non-equilibrium strategy is weakly worse than not deviating. According to the expected utility, we check two cases: deviation when $t_i \in [\underline{t}, t')$ and when $t_i \in [t', \bar{t}]$.

Case 1: deviation when $\boldsymbol{t_i} \in [\underline{\boldsymbol{t}}, \boldsymbol{t'})$

In this case, $s_i^{TG}(t_i) = (P, L(t_i) - W(t_i), give)$. We check that when $(\rho_i, b_i, d_i) \neq s_i^{TG}(t_i)$ is not better. Suppose $d_i = take$, it is best to submit with bid $b_i = 0$; hence, by comparing the expected utility

$$\Delta^3(t_i) = u_i^*(t_i) - u_i\big(t_i, (P, 0, take)\big|s_j^{TG}\big) = \int_{t_i}^{t'} [L(t_i) - W(t_i) + W(t) - L(t)]dF(t).$$

Obviously, $\Delta^3(t_i) \geq 0$ for $\forall t_i \in [\underline{t}, t')$.

Next, suppose $b_i \neq L(t_i) - W(t_i)$, he gets less expected utility than $u_i^*(t_i)$. Last, suppose $\rho_i = N$, regardless of b_i and d_i he gets $\int_{\underline{t}}^{t'} W(t_i)dF(t) + \int_{t'}^{\bar{t}} L(t_i)dF(t)$; by comparing the expected utility, the deviation yields less than $u_i^*(t_i)$. Hence, we finish showing the case.

Case 2: deviation when $t_i \in [t', \bar{t}]$

In this case, $s_i^{TG}(t_i) = (P, W(t_i) - L(t_i), take)$. We check that when $(\rho_i, b_i, d_i) \neq s_i^{TG}(t_i)$ is not better. Follow similar steps as in the previous case. The arguments show that it is the equilibrium strategy. Hence, we finish the proof.

Q.E.D.

B.5. Proof of Proposition 7.1-1

The proof directly shows that playing the equilibrium strategy is better than playing other out-of-equilibrium strategy. According to the equilibrium strategy, in the case of high type realization, t_h, playing the equilibrium strategy yields $\left(\frac{W(t_h)-E_{take}}{W(t_h)}\right)^2$, $2\left(\frac{W(t_h)-E_{take}}{W(t_h)}\right)\left(\frac{E_{take}}{W(t_h)}\right)$ and $\left(\frac{E_{take}}{W(t_h)}\right)^2$ chance of participating by both bidders, participating by only one bidder and no participant. If both participate, the bidder *i* pays the fee E_{take} and has 0.5 chance of paying $W(t_h) - L(t_h)$ and being obtainer (which yields him $W(t_h)$ payoff) and 0.5 chance of paying nothing and his opponent being obtainer (which yields him $L(t_h)$ payoff). If the bidder *i* participates but his opponent does not, he obtains the object and pays only the fee E_{take}. If his opponent participates but he does not, his opponent obtains it and he pays nothing. And, if both do not participate, the seller keeps the object (which yields each bidder 0 payoff and pays nothing). Hence, the bidder *i*'s expected utility is

$$u_{i,t_h}^* = u_{i,t_h}\left(s_i^{TGF}(t_h) \middle| s_j^{TGF}(t_h)\right) = \frac{L(t_h)(W(t_h) - E_{take})}{W(t_h)},$$

where $s_i^{TGF}(t_h) = \left(\rho^{TGF}(t_h), b^{TGF}(t_h), d^{TGF}(t_h)\right)$ is the bidder i playing the high-type equilibrium strategy. Deviating to other strategy $(\rho_i, b_i, d_i) \neq s_i^{TGF}(t_h)$ is not better. To see this, (given bidder *j* strictly plays the equilibrium strategy) suppose $d_i = give$ then this out-of-equilibrium strategy yields him

$$u_{i,t_h}\left((\rho^{TGF}(t_h), b^{TGF}(t_h), give) \middle| s_j^{TGF}(t_h)\right) = \frac{L(t_h)\left(W(t_h)^2 - {E_{take}}^2\right)}{W(t_h)^2} - \frac{E(W(t_h) - E_{take})}{W(t_h)} \leq u_{i,t_h}^*.$$

Suppose $\rho_i = \left(\frac{W(t_h)-E_{take}}{W(t_h)} + \varepsilon\right)P + \left(\frac{E_{take}}{W(t_h)} - \varepsilon\right)N$ for any $\varepsilon \neq 0$, it yields him u_{i,t_h}^*; suppose $b_i \neq W(t_h) - L(t_h)$, it yields him u_{i,t_h}^*. Hence, we finish showing that $s_i^{TGF}(t_h)$ is the symmetric-equilibrium strategy for high type realization.

By showing similar arguments, we can prove that $(\frac{L(t_l)-E_{give}}{L(t_l)}P + \frac{E_{give}}{L(t_l)}N, L(t_l) - W(t_l), give)$ is the symmetric-equilibrium strategy for low type realization, t_l. We finish the proof.

Q.E.D.

B.6. Proof of Proposition 7.1-2

To prove the proposition, we show that playing the equilibrium strategy is better than deviating to other strategies. If both bidders play the equilibrium strategy, expected utility of bidder i is derived into three piecewises: when the bidder has $t_i \in [\underline{t}, \dot{t}]$, $t_i \in (\dot{t}, \ddot{t})$ and $t_i \in [\ddot{t}, \bar{t}]$. When the bidder has $t_i \in [\underline{t}, \dot{t}]$, he participates with $L(t_i) - W(t_i)$ bid and demand to give; hence, he pays E_{give}. And, with $F(t_i)$, $F(\dot{t}) - F(t_i)$ and $1 - F(\dot{t})$ chance, he receives (from his opponent) the object without payment, gives it with $L(t_j) - W(t_j)$ payment and gives it without payment (since the opponent demands to take). Similarly, we can derive the expected utility when the bidder has $t_i \in (\dot{t}, \ddot{t})$ and $t_i \in [\ddot{t}, \bar{t}]$. The bidder *i*'s expected utility is presented as follows:

$$u_i^*(t_i) = u_i\left(t_i, s_i^{TGF}(t_i) \middle| s_j^{TGF}\right)$$
$$= \begin{cases} -E_{give} + \int_{\underline{t}}^{t_i} W(t_i)dF(t) + \int_{t_i}^{\dot{t}} \big(L(t_i) - L(t) + W(t)\big)dF(t) + \int_{\dot{t}}^{\bar{t}} L(t_i)dF(t) \;\; for\; t_i \in [\underline{t}, \dot{t}] \\ \int_{\underline{t}}^{\dot{t}} W(t_i)dF(t) + \int_{\ddot{t}}^{\bar{t}} L(t_i)dF(t) \;\; fot\; t_i \in (\dot{t}, \ddot{t}) \\ -E_{take} + \int_{\underline{t}}^{\ddot{t}} W(t_i)dF(t) + \int_{\ddot{t}}^{t_i} \big(W(t_i) - W(t) + L(t)\big)dF(t) + \int_{t_i}^{\bar{t}} L(t_i)dF(t) \;\; for\; t_i \in [\ddot{t}, \bar{t}] \end{cases},$$

where $s_i^{TGF}(t_i) = \left(\rho^{TGF}(t_i), b^{TGF}(t_i), d^{TGF}(t_i)\right)$ is the bidder i playing the equilibrium strategy of corresponding type.

Then, we check that deviating to other non-equilibrium strategy is weakly worse than not deviating. According to the expected utility, we check three cases: deviation when $t_i \in [\underline{t}, \dot{t}]$, when $t_i \in (\dot{t}, \ddot{t})$ and when $t_i \in [\ddot{t}, \bar{t}]$.

Case 1: deviation when $\boldsymbol{t_i} \in (\dot{\boldsymbol{t}}, \ddot{\boldsymbol{t}})$

In this case, $s_i^{TGF}(t_i) = (N, 0, any)$. We check that when $(\rho_i, b_i, d_i) \neq s_i^{TGF}(t_i)$ is not better. Suppose $\rho_i = P$ and $d_i = give$, it is best to submit with bid $b_i = 0$; hence, by comparing the expected utility

$$\Delta^4(t_i) = u_i^*(t_i) - u_i\left(t_i, (P, 0, give)\middle| s_j^{TGF}\right) = E_{give} - \int_{\dot{t}}^{\ddot{t}} L(\dot{t})dF(t).$$

We need to show that $\Delta^4(t_i) \geq 0$ for $\forall t_i \in (\dot{t}, \ddot{t})$. According to (7.1-1), $\Delta^4(t_i) = 0$ which satisfies the condition. Next, suppose $\rho_i = P$ and $d_i = take$, by following the similar steps, we can show that it satisfies the condition. We finish the case.

Case 2: deviation when $\boldsymbol{t_i \in [\underline{t}, \dot{t}]}$

In this case, $s_i^{TGF}(t_i) = (P, L(t_i) - W(t_i), give)$. We check that when $(\rho_i, b_i, d_i) \neq s_i^{TGF}(t_i)$ is not better. Suppose deviating to $b_i \neq L(t_i) - W(t_i)$, directly the strategy $(\rho^{TGF}, b_i, d^{TGF})$ is not better than s_i^{TGF}. Suppose $\rho_i = N$, regardless of b_i and d_i, by comparing the expected utility together with (7.1-1), we can show that the condition is satisfied. Suppose $d_i = take$, it is best to submit with $b_i = 0$; hence, by comparing the expected utility, we get

$$\Delta^5(t_i) = u_i^*(t_i) - u_i\big(t_i, (P, 0, take)\big|s_j^{TGF}\big) = E_{take} - E_{give} - \int_{\dot{t}}^{\ddot{t}} \big(W(\dot{t}) - L(\dot{t})\big) dF(t).$$

We need to show that $\Delta^5(t_i) \geq 0$ for $\forall t_i \in [\underline{t}, \dot{t}]$. According to (7.1-1), $\Delta^5(t_i) > 0$ which satisfies the condition. Hence, we finish the case.

Case 3: deviation when $\boldsymbol{t_i \in [\ddot{t}, \bar{t}]}$

In this case, $s_i^{TGF}(t_i) = (P, W(t_i) - L(t_i), give)$. We check that $(\rho_i, b_i, d_i) \neq s_i^{TGF}(t_i)$ is not better. Suppose deviating to $b_i \neq W(t_i) - L(t_i)$, directly the strategy $(\rho^{TGF}, b_i, \epsilon^{TGF})$ is not better than s_i^{TGF}. Suppose $\rho_i = N$, regardless of b_i and d_i, by comparing the expected utility together with (7.1-1), we can show that the condition is satisfied. Suppose $d_i = give$, it is best to submit with $b_i = 0$; hence, by comparing the expected utility, we get

$$\Delta^6(t_i) = u_i^*(t_i) - u_i\big(t_i, (P, 0, give)\big|s_j^{TGF}\big) = E_{give} - E_{take} + \int_{\dot{t}}^{\ddot{t}} \big(W(\ddot{t}) - L(\ddot{t})\big) dF(t).$$

We need to show that $\Delta^6(t_i) \geq 0$ for $\forall t_i \in [\ddot{t}, \bar{t}]$. According to (7.1-1), $\Delta^6(t_i) > 0$ which satisfies the condition. Hence, we finish the case and finish proving the proposition.

Q.E.D.

B.7. Proof of Proposition 7.2-1

To prove the proposition, we show that playing the equilibrium strategy is better than deviating to other strategies. If both bidders play the equilibrium strategy, expected utility of bidder *i* is derived into three piecewises: when the bidder has $t_i \in [\underline{t}, t^*]$, $t_i \in (t^*, t^{**})$ and $t_i \in [t^{**}, \bar{t}]$. When the bidder has $t_i \in [\underline{t}, t^*]$, he participates with $L(t_i) - W(t_i)$ bid and demand to give; hence, he pays E_{give}. And, with $F(t_i)$, $F(\dot{t}) - F(t_i)$ and $1 - F(\dot{t})$ chance, he respectively receives (from his opponent) the object without payment, gives it with $L(t_j) - W(t_j)$ payment and gives it without payment (since the opponent demands to take). Similarly, we can derive the expected utility when the bidder has $t_i \in (t^*, t^{**})$ and $t_i \in [t^{**}, \bar{t}]$. The bidder *i*'s expected utility is presented as follows:

$$u_i^*(t_i) = u_i\big(t_i, s_i^{TGI}(t_i)\big|s_j^{TGI}\big)$$

$$= \begin{cases} -E_{give} + \int_{\underline{t}}^{t_i} W(t_i)dF(t) + \int_{t_i}^{t^*} \big(L(t_i) - L(t) + W(t)\big)dF(t) + \int_{t^*}^{\bar{t}} L(t_i)dF(t) \ for \ t_i \in \big[\underline{t}, t^*\big] \\ -E_{pool} + \int_{\underline{t}}^{t^*} W(t_i)dF(t) + \int_{t^*}^{t^{**}} \frac{1}{2}\big(W(t_i) + L(t_i)\big)dF(t) + \int_{t^{**}}^{\bar{t}} L(t_i)dF(t) \ fot \ t_i \in (t^*, t^{**}) \\ -E_{take} + \int_{\underline{t}}^{t^{**}} W(t_i)dF(t) + \int_{t^{**}}^{t_i} \big(W(t_i) - W(t) + L(t)\big)dF(t) + \int_{t_i}^{\bar{t}} L(t_i)dF(t) \ for \ t_i \in \big[t^{**}, \bar{t}\big] \end{cases}.$$

where $, s_i^{TGI}(t_i) = \big(\rho^{TGI}, b^{TGI}(t_i), d^{TGI}(t_i)\big)$ is the bidder i playing the equilibrium strategy of corresponding type.

Then, we check that deviating to other non-equilibrium strategy is weakly worse than not deviating. According to the expected utility, we check three cases: deviation when $t_i \in (t^*, t^{**})$, when $t_i \in \big[\underline{t}, t^*\big]$ and when $t_i \in \big[t^{**}, \bar{t}\big]$.

Case 1: deviation when $\boldsymbol{t_i} \in (\boldsymbol{t^*}, \boldsymbol{t^{**}})$

In this case, $s_i^{TGI}(t_i) = (P, 0, indifference)$. We check that when $(\rho_i, b_i, d_i) \neq s_i^{TGI}(t_i)$ is not better. Suppose $\rho_i = N$, regardless of b_i and d_i, according to the no sale condition, the deviation yields 0 payoff; by comparing the expected utility, we get

$$\Delta^7(t_i) = u_i^*(t_i) - u_i\big(t_i, (N, b_i, d_i)\big|s_j^{TGI}\big)$$
$$= -E_{pool} + \int_{\underline{t}}^{t^*} W(t_i)dF(t) + \int_{t^*}^{t^{**}} \frac{1}{2}\big(W(t_i) + L(t_i)\big)dF(t)$$
$$+ \int_{t^{**}}^{\bar{t}} L(t_i)dF(t).$$

We need to show that $\Delta^7(t_i) \geq 0$ for $\forall t_i \in (t^*, t^{**})$. Since $\frac{\partial \Delta^7(t_i)}{\partial t_i} = \frac{1}{2}(a + b)\big(F(t^{**}) + F(t^*)\big) - b$, we know that $\Delta^7(t_i)$ is linear. According to (7.2-1), we can show that $\Delta^7(t^*) \geq 0$ and $\Delta^7(t^{**}) \geq 0$. Hence, it implies that $\Delta^7(t_i) \geq 0$ for $\forall t_i \in (t^*, t^{**})$.

Suppose $d_i = take$, it is best to submits with $b_i = 0$; hence, by comparing the expected utility, we get

$$\Delta^8(t_i) = u_i^*(t_i) - u_i\big(t_i, (P, 0, take)\big|s_j^{TGI}\big) = E_{take} - E_{pool} + \int_{t^*}^{t^{**}} \frac{1}{2}\big(L(t_i) - W(t_i)\big)dF(t).$$

We need to show that $\Delta^8(t_i) \geq 0$ for $\forall t_i \in (t^*, t^{**})$. Since $\frac{\partial \Delta^8(t_i)}{\partial t_i} < 0$, we need $\Delta^8(t^{**}) \geq 0$. According to (7.2-1), $\Delta^8(t^{**}) = 0$ and satisfies the condition.

Suppose $d_i = give$, it is best to submits with $b_i = 0$; hence, by comparing the expected utility, we get

$$\Delta^9(t_i) = u_i^*(t_i) - u_i\big(t_i, (P, 0, give)\big|s_j^{TGI}\big) = E_{give} - E_{pool} + \int_{t^*}^{t^{**}} \frac{1}{2}\big(W(t_i) - L(t_i)\big)dF(t).$$

We need to show that $\Delta^9(t_i) \geq 0$ for $\forall t_i \in (t^*, t^{**})$. Since $\frac{\partial \Delta^9(t_i)}{\partial t_i} > 0$, we need $\Delta^9(t^*) \geq 0$. According to (7.2-1), $\Delta^9(t^*) = 0$ and satisfies the condition. Hence, we finish showing that $(P, 0, pool)$ is the equilibrium strategy when $t_i \in (t^*, t^{**})$.

Case 2: deviation when $\boldsymbol{t_i} \in [\underline{\boldsymbol{t}}, \boldsymbol{t}^*]$

In this case, $s_i^{TGI}(t_i) = (P, L(t_i) - W(t_i), give)$. We check that when $(\rho_i, b_i, d_i) \neq s_i^{TGI}(t_i)$ is not better. Suppose $\rho_i = N$, regardless of b_i and d_i, according to the no sale condition, the deviation yields 0 payoff; by comparing the expected utility, we get

$$\Delta^{10}(t_i) = u_i^*(t_i) - u_i\big(t_i, (N, b_i, d_i)\big|s_j^{TGI}\big)$$
$$= -E_{give} + \int_{\underline{t}}^{t_i} W(t_i) dF(t) + \int_{t_i}^{t^*} \big(L(t_i) - L(t) + W(t)\big) dF(t)$$
$$+ \int_{t^*}^{\bar{t}} L(t_i) dF(t).$$

We need to show that $\Delta^{10}(t_i) \geq 0$ for $\forall t_i \in [\underline{t}, t^*]$. We know that $\frac{\partial \Delta^{10}(t_i)}{\partial t_i} = (a+b)\left(F(t_i) - \frac{b}{a+b}\right)$. Since $t_i \leq t^{min}$ and according to (7.2-1), we know that $\frac{\partial \Delta^{10}(t_i)}{\partial t_i} < 0$. Also, as a sufficient condition in (7.2-1) -- $\int_{\underline{t}}^{t^*} W(t^*) dF(t) + \int_{t^*}^{\bar{t}} L(t^*) dF(t) \geq E_{give}$ -- then $\Delta^{10}(t_i) \geq 0$ for $\forall t_i \in [\underline{t}, t^*]$.

Suppose $d_i = take$, it is best to submits with $b_i = 0$; hence, by comparing the expected utility, we get

$$\Delta^{11}(t_i) = u_i^*(t_i) - u_i\big(t_i, (P, 0, take)\big|s_j^{TGI}\big)$$
$$= E_{take} - E_{give} + \int_{t_i}^{t^*} \big(L(t_i) - W(t_i) - L(t) + W(t)\big) dF(t)$$
$$+ \int_{t^*}^{t^{**}} \big(L(t_i) - W(t_i)\big) dF(t).$$

We need to show that $\Delta^{11}(t_i) \geq 0$ for $\forall t_i \in [\underline{t}, t^*]$. Since $\frac{\partial \Delta^{11}(t_i)}{\partial t_i} < 0$, we need $\Delta^{11}(t^*) \geq 0$. According to (7.2-1), we can show that $\Delta^{11}(t^*) > 0$ which satisfies the condition.

Suppose $d_i = indifference$, regardless of b_i, by comparing the expected utility we get

$$\Delta^{12}(t_i) = u_i^*(t_i) - u_i\big(t_i, (P, b_i, indifference)\big|s_j^{TGI}\big)$$
$$= E_{pool} - E_{give} + \int_{t_i}^{t^*} \big(L(t_i) - W(t_i) - L(t) + W(t)\big) dF(t)$$
$$+ \int_{t^*}^{t^{**}} \frac{1}{2}\big(L(t_i) - W(t_i)\big) dF(t).$$

We need to show that $\Delta^{12}(t_i) \geq 0$ for $\forall t_i \in [\underline{t}, t^*]$. Since $\frac{\partial \Delta^{12}(t_i)}{\partial t_i} < 0$, we need $\Delta^{12}(t^*) \geq 0$. According to (7.2-1), we can show that $\Delta^{12}(t^*) = 0$ which satisfies the condition. Hence, we finish showing that $(P, L(t_i) - W(t_i), give)$ is the equilibrium strategy when $t_i \in [\underline{t}, t^*]$.

Case 3: deviation when $\boldsymbol{t_i} \in [\boldsymbol{t}^{**}, \bar{\boldsymbol{t}}]$

In this case, $s_i^{TGI}(t_i) = (P, W(t_i) - L(t_i), take)$. We check that when $(\rho_i, b_i, d_i) \neq s_i^{TGI}(t_i)$ is not better. Suppose $\rho_i = N$, regardless of b_i and d_i, according to the no sale condition, the deviation yields 0 payoff; by comparing the expected utility, we get

$$\Delta^{13}(t_i) = u_i^*(t_i) - u_i\big(t_i,(N,b_i,d_i)\big|s_j^{TGI}\big)$$
$$= -E_{take} + \int_{\underline{t}}^{t^{**}} W(t_i)dF(t) + \int_{t^{**}}^{t_i} \big(W(t_i) - W(t) + L(t)\big)dF(t)$$
$$+ \int_{t_i}^{\bar{t}} L(t_i)dF(t).$$

We need to show that $\Delta^{13}(t_i) \geq 0$ for $\forall t_i \in [t^{**},\bar{t}]$. We know that $\frac{\partial\Delta^{13}(t_i)}{\partial t_i} = (a+b)\left(F(t_i) - \frac{b}{a+b}\right)$. Since $t_i \geq t^{min}$ and according to (7.2-1), we know that $\frac{\partial\Delta^{13}(t_i)}{\partial t_i} > 0$. Also, as a sufficient condition in (7.2-1) -- $\int_{\underline{t}}^{t^{**}} W(t^{**})dF(t) + \int_{t^{**}}^{\bar{t}} L(t^{**})dF(t) \geq E_{take}$ -- then $\Delta^{13}(t_i) \geq 0$ for $\forall t_i \in [t^{**},\bar{t}]$.

Suppose $d_i = give$, it is best to submits with $b_i = 0$; hence, by comparing the expected utility, we get

$$\Delta^{14}(t_i) = u_i^*(t_i) - u_i\big(t_i,(P,0,give)\big|s_j^{TGI}\big)$$
$$= E_{give} - E_{take} + \int_{t^*}^{t^{**}} \big(W(t_i) - L(t_i)\big)dF(t)$$
$$+ \int_{t^{**}}^{t_i} \big(W(t_i) - L(t_i) - W(t) + L(t)\big)dF(t).$$

We need to show that $\Delta^{14}(t_i) \geq 0$ for $\forall t_i \in [t^{**},\bar{t}]$. Since $\frac{\partial\Delta^{14}(t_i)}{\partial t_i} > 0$, we need $\Delta^{14}(t^{**}) \geq 0$. According to (7.2-1), we can show that $\Delta^{14}(t^*) > 0$ which satisfies the condition.

Suppose $d_i = indifference$, regardless of b_i, by comparing the expected utility we get

$$\Delta^{15}(t_i) = u_i^*(t_i) - u_i\big(t_i,(P,b_i,indifference)\big|s_j^{TGI}\big)$$
$$= E_{pool} - E_{take} + \int_{t^*}^{t^{**}} \frac{1}{2}\big(W(t_i) - L(t_i)\big)dF(t)$$
$$+ \int_{t^{**}}^{t_i} \big(W(t_i) - L(t_i) - W(t) + L(t)\big)dF(t).$$

We need to show that $\Delta^{15}(t_i) \geq 0$ for $\forall t_i \in [t^{**},\bar{t}]$. Since $\frac{\partial\Delta^{15}(t_i)}{\partial t_i} > 0$, we need $\Delta^{15}(t^{**}) \geq 0$. According to (7.2-1), we can show that $\Delta^{15}(t^{**}) = 0$ which satisfies the condition. Hence, we finish showing that $(P, W(t_i) - L(t_i), take)$ is the equilibrium strategy when $t_i \in [\underline{t}, t^*]$. We finish the proof of proposition.

Q.E.D.

B.8. Proof of Proposition 7.3-1

This section proves the take-give-indifference auction with entry fee is equivalent to the optimal auction of Chen and Potipiti (2010). In other words, the auction is the revenue-maximizing auction. To prove it, we show that the characterizations of the auction and of the optimal auction are equivalent.

In Chen and Potipiti (2010), its optimal auction is characterized by the following optimization problem:

PROBLEM B.8-1

$$\max_{x_i, x_j, Eu_i(\underline{t})} ER$$

$$s.t.$$

$$x_i + x_j \leq 1 \qquad (F)$$

$$Q(t_i) = a\int_{\underline{t}}^{\bar{t}} x_i(t_i, t_j)dF(t_j) - b\int_{\underline{t}}^{\bar{t}} x_2(t_i, t_j)dF(t_j) \text{ } is\ non\ decreasing\ in\ \forall t_i \in T \quad (ND)$$

$$Eu_i(t_i) = Eu_i(\underline{t}) + \int_{\underline{t}}^{t_i}[Q(z)]dz \geq 0\ for\ \forall t_i \in T \qquad (IR)$$

$$Eu_i(\underline{t}) = -\int_{\underline{t}}^{t^{***}}[Q(z)]dz\ where\ t^{***} \in \operatorname*{argmin}_t \int_{\underline{t}}^{t}[Q(z)]dz \qquad (BB)$$

where x_i is the probability of being the obtainer of bidder i; Eu_i is the expected utility of bidder i.[34]

Intuitively, (F) specifies the feasible allocation which the sum of probability of obtaining the object of each bidder is at most one; the sum is less than one when there is some chance that the seller keeps the object. (ND) comes from the incentive-compatible constraint. (IR) is the individual-rational constraint. And, (BB) selects the binding type t^{***}.

In the take-give-indifference auction, as presented in Proposition 7.2-1, the equilibrium strategy shows that the allocation is directly equivalent to (F) (see Figure 7.2-2 on the right). The following here, we will show that (7.2-1) in Assumption 7.2-1 is equivalent to (ND), (IR) and (BB).

First, in the take-give-indifference auction we can derive $Q(t_i)$ as follows:

$$Q(t_i) = \begin{cases} (a+b)F(t_i) - b\ for\ t_i \in [\underline{t}, t^*] \\ (a+b)\left(\dfrac{F(t^*) + F(t^{**})}{2}\right) - b\ for\ t_i \in (t^*, t^{**}). \\ (a+b)F(t_i) - b\ for\ t_i \in [t^{**}, \bar{t}] \end{cases} \qquad (B.8-1)$$

To show that $Q(t_i)$ is non-decreasing in type, we derive the first-order derivative as follows:

$$\frac{\partial Q(t_i)}{\partial t_i} = \begin{cases} (a+b) * f(t_i)\ for\ t_i \in [\underline{t}, t^*] \\ 0\ for\ t_i \in (t^*, t^{**}) \\ (a+b) * f(t_i)\ for\ t_i \in [t^{**}, \bar{t}] \end{cases}.$$

The first-order derivative of $Q(t_i)$ shows that $Q(t_i)$ is non-decreasing in type. Hence, the auction has equivalent non-decreasing property as of the optimal auction.

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34 (BB) comes from Lemma 2 in Chen and Potipiti (2010).

Second, (IR) specifies that in the optimal auction expected utility of any type is weakly higher than zero. Recall that in the take-give-indifference auction the equilibrium strategy is that a bidder with any type always participates. Since the no sale condition makes a bidder get zero utility if he does not participate, the equilibrium strategy directly implies that playing the equilibrium strategy (always participate) yields weakly higher utility than not participating (which yields zero utility). Hence, the auction has equivalent individual-rational property as of the optimal auction.

Last, for (BB) which selects the binding type in the optimal auction, it is equivalent to $t^{min} = F^{-1}\left(\frac{b}{a+b}\right)$ in (7.2-1) of the take-give-indifference auction. To show this, we show that the characterization of the auction satisfies (BB). From the equilibrium strategy as specified in Proposition 7.2-1, we derive the expected utility of the lowest type $Eu_i(\underline{t})$ as,

$$Eu_i(\underline{t}) = -E_{give} + \int_{\underline{t}}^{t^*} \left(L(\underline{t}) - L(t) + W(t)\right) dF(t) + \int_{t^*}^{\bar{t}} L(\underline{t}) dF(t) \qquad (B.8-2)$$

where, according to (7.2-1), $E_{give} = W(t^{min})F(t^*) + \frac{1}{2}\left(F(t^{**}) - F(t^*)\right)\left(W(t^{min}) - W(t^*) + L(t^{min}) + L(t^*)\right) + L(t^{min})\left(1 - F(t^{**})\right)$. Then, we apply (B.9-1) to derive $-\int_{\underline{t}}^{t^{***}} [Q(z)]dz$. Assume that $t^{min} = t^{***}$, $-\int_{\underline{t}}^{t^{min}} [Q(z)]dz$ is

$$\begin{aligned} -\int_{\underline{t}}^{t^{min}} [Q(z)]dz \\ &= b\left(t^{min} - \underline{t}\right) - (a+b)\int_{\underline{t}}^{t^*} F(z)dz \\ &- \frac{1}{2}(a+b)(F^* + F^{**})\left(t^{min} - t^*\right). \qquad (B.8-3) \end{aligned}$$

We can show that (B.9-2) (which is on the left-hand side of (BB)) is equal to (B.9-3) (which is on the right-hand side of (BB)). Hence, we finish showing that $t^{min} = t^{***}$ as the binding type of the optimal auction. We finish the proof.

Q.E.D.

BIOGRAPHY

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