Responsiveness to Incentives in Organ Donation Decisions: A Laboratory Experiment

Abstract

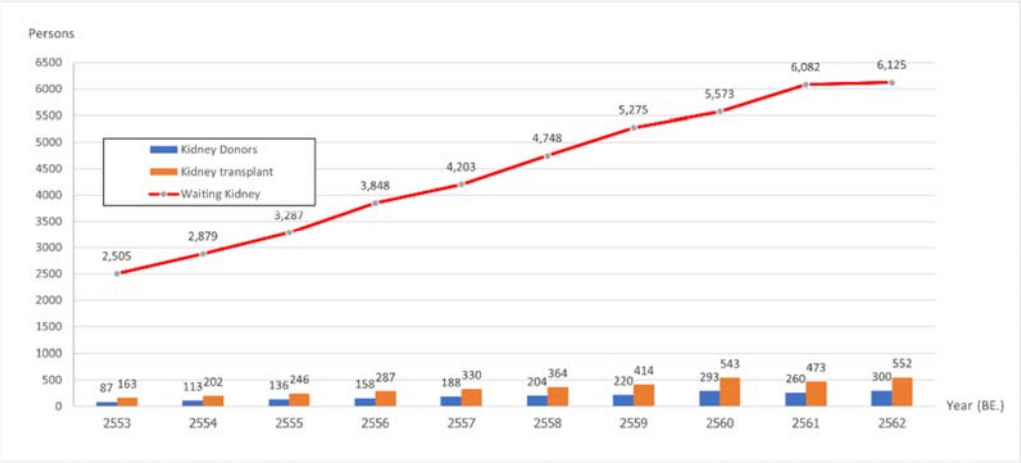
In Thailand, there has been an increasing number of waiting patients who are in the queue for organ transplant. This research investigates the optimal organ allocation rule which creates incentive to donors. We focus on three allocation rules, which are first come, first serve (the status quo), rebate, and priority rule. The rebate rule is that donors receive payment for donating, while donors have priority in the priority rule when they need an organ. This research incorporates the uncertainty in organ compatibility between the receiver and the giver. We design the experiment to observe when subjects make a decision to donate organs. We find that subjects response the most to the priority rule and the compatibility factor plays a crucial role when subjects make a decision.

Keywords: Organ Allocation Rule, Organ Donation, Behavioral Economics.

1. Introduction

The scarcity of organs has been a problem in many countries around the world, including Thailand. According to the Annual Report of Organ Donation Center in 2019, the number of waiting patients are increasing substantially whereas the number of organ receivers and organ donors remain rather steady (see Figure 1)[1]. Approximately 85% of waiting patients have kidney failure and belong in the kidney dialysis treatment. One of the reasons that the number of waiting patients rise up very fast is that the dialysis cost is subdized by the social security system (4,500 Baht per week). Furthermore, in the case that they have received the organ, the cost of transpantation and cyclosporine, medicine that receiver has to take entire life, are fully subsidized. Therefore, the queue for waiting kidney exchange is the longest. The average waiting time for kidney transplantation is approxitmately 5 years and there have been 900 patients who die during waiting period since 2010. According to the trend of increasing waiting patients, the scarcity situation of organ will be worse off in future. This challenges the involving organizations in dealing with this problem.

Figure 1: The number of organ donors, organ receivers and waiting patients .



[1] The difference between donor and registered donor is that the registered donor is the people who intend to be donors but have not yet transplanted to give their organs to others, whereas the donors have already given. The registered donor will be a donor when the brain is death. See detail in Supply of organ in section 2.

In Economics, we call this situation excess demand and the most effective way to reduce such demand is to use market pricing mechnism, in which the price will rise. Unfortunately, selling and buying organs are prohibited by law and the market is constrained from an ethical standpoint. Alternatively, another way to remedy such scarcity is to increase the number of registered donors.

We ask which allocation rule is more effective to incentivize people to donate organs. In particular, this paper investigated two organ allocation rules, namely, the rebate and the priority rules. In an experiment, we run two treatment groups and a control group. The control group employs the first come, first serve rule in which the longest waiting subject receives an organ first. It is the current implementation (status quo) in Thailand. In the rebate rule, a donor is awarded by a rebate scheme. We are interested in this rule because it has been applied in some countries. In USA, organ donors can deduct their income tax up to $10,000.[2] The priority allocation rule is that a donor will benefit from the priority when she need an organ. For instance, suppose there is a piece of organ available but there are five subjects in the waiting list. Patient who has donated previously but, in turn, is in need of an organ will receive that organ, regardless of how long she has been waiting. There are a few countries that apply this rule such as Singapore and Israel.[3]

This paper contributes to literatures in twofold. First, we extend Kessler and Roth (2012) by incorporating the risk of organ compatibility between the givers and the receivers. It means that the patient who is on top of the waiting list might not be able to receive the organ because the organ is not compatible with her body.[4] In the experiment, we assign different types to subjects. There are two types which different in the flexibility of receiving the organ. One can receive universally; on the other hand, another type can obtain only from givers who are the same type. The result shows that the difference in type is significant for subjects when they decide to donate. In addition, to compare the incentive among allocation rules, we control the benefit from receiving organ across treatments. In particular, the amount of income that donors receive in the rebate scheme is the same as the benefit when subjects receive an organ in the priority rule. In other words, we equalize the gain of donors between rebate and priority rule. Therefore, the difference in the number of donors is from the difference in allocation rule. We find that the priority rule creates the most incentive to induce subjects donation of organs.

The organization of paper is following. We overview basic information of organ donation in section 2. Section 3 provides the literature review, and the experimental design is given in section 4. The results are in section 5 and the conclusion is provided in section 6.

2. Supply of organs

The organ donation systems

There are two systems of organ donation, which are opt in and opt out. In the opt in system, people are non-donors (the default option is non-donors). If they want to be a donor, they can register as a registered donor. By contrast, in the opt out system, people are donors by default, but they can abandon the option by registering to be non-donors. Examples of opt in countries are Thailand, Brazil, Australia, etc.; while, examples of opt out countries are Spain, Sweden, Singapore, etc. (Shepherd et. al (2014))

[2] See detail in https://www.alec.org/model-policy/organ-donation-tax-deduction-act/#:~:text=Summary,one%20or%20more%20human%20organs.

[3] In USA, an organ allocation is not monopolized by central organ donation center as other countries. There are several organ centers and each center has their own rule. However, many centers have applied priority rule to members.

[4] In reality, the compatibility is calculated in form of score and the score varies on the degree of alignment between organ and waiting patients in several factors such as waiting time, blood type, HLA mismatch, etc.

Living and Deceased donors

Donors are divided into two categories, living and deceased donors. A living donor is a donor who donates a part of organ such as one piece of kidneys to other people and still live after giving. By law, giver and taker are restricted that they must be in the same family. The giving among friends are not approved legally. On the other hand, a deceased donor is a brain death donor who has died before donating. By law, the definition of death is brain death.[5] After diagnosing that the brain is death but subject still breathes, doctor will perform a surgery to bring organs out. Because deceased donor can give more organs than living donor does, this paper will focus on deceased donor.

According to an interview with a health officer, most organs currently are donated from deceased donors but they themselves do not consent. The donors do not register as a registered donor. When the brain of a patient has died, nurses often enquire from the next of kin to consent the patient in becoming a deceased donor. If they consent, the doctors can operate. With the current system, most of the supply of organs depends on officers' asking and next of kin's consenting. Unfortunately, the decision at that very moment is very difficult and most of them wait for the last-minute miracle which can be too late to extract organs. However, we believe that if the next of kin is aware of the intention of the patient that she wants to be a donor and she already register as a registered donor, it might be easier for the next of kin to consent. Therefore, raising the number of registered donors is a way to increase supply of organ and reduce waiting time.

3. Literature reviews

To be added

4. Experimental design

The experimental design was modified from Kessler and Roth (2012). The subjects were assigned into different groups. In each group, there were 12 subjects without reshuffle throughout the experiment. A subject had to decide whether to be a donor for 30 rounds. At the beginning of an experiment, a subject was informed that she had 2 goods, 1 piece of A (represent the brain), and 2 pieces of B (represent the kidneys).[6] Before each round started, subjects decided whether she would register to donate kidneys.[7] After deciding, there were 10 periods in which the probability that the brain was death is assigned at 10% and the chance of kidney failure was 20%. If the brain had died, that round was terminated. On the other hand, if the kidneys had failed, the subject could wait for 5 periods. During waiting periods, if she receives the kidney, she remained alive. Otherwise, the round ended. In the case that she received the kidney, that kidney was not able to pass to others.

In case that a registered donor's brain has died, her kidneys will be given to 2 subjects. Receiving the kidney depended on both the organ compatibility and the kidney allocation rule. In each group, there were 2 types of subjects who were different in probability of matching between them and donor. One type had organ compatibility of 100% and another had 50% (see detail below). This probability assignment did not change throughout the experiment.

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[5] The logic is that one of the main functions of the brain is to control breathing and heartbeat. When the brain is death, the breathing and heartbeat automatically stop soon after. By law, brain death diagnostic requires the unanimity of at least two doctors' opinion.

[6] We intentionally used the neutral word "goods", rather than the direct word "brain and kidneys". The reason was that we wanted to remove background knowledge in organ donation of subjects. Otherwise, subject might decide, based on culture, religion, etc.

[7] In the experiment, the registered donor automatically donates when the brain had died without any consented from third party as the reality. Therefore, we replaced registered donor as donor.

The subject is still alive if her brain is good and she has at least one piece of kidney. She receives an increment of 20 Baht in every round that she lives. The payoff stopped if she died or are in waiting periods. We randomly chose 4 rounds to average the payoff to subjects when the experiment terminated.

The subject decided to donate before she knew the status of brain and kidneys in that round. In being a donor, subject paid 10 Baht. This monetary cost represents the cost of registration to be a donor. Although registration as a donor currently incurs very low cost because the donor can register online on through the official website of Organ Donation Center, the real cost of organ donation can also be think of as a psychological cost. There are many reasons that people are afraid of organ donation; for instance, it might hurt, they afraid that doctors will operate on them too early, they think the doctors might not pay full attention to help them, they wait for a last minute miracle, they believe that they will be disable in future life, etc. Adding the monetary cost is a way to represent those fears in the experiment.

The information that were given to subjects at the end of each round were the status of brain and kidneys, the periods that they had been waiting, the result of organ allocation and the payoff. Subjects do not know the number of donors in a given round.

Figure 2: Subjects' screen server

Types of subjects

In each group, we categorized subjects into 2 types, which were 6 subjects of type X and 6 subjects of type Y. For subjects of type X, they could match with any organ regardless of type of donor. However, subjects of type Y could only be matched with type Y donor. In other words, the organ compatibility was 100% and 50% for type X and Y, respectively. One of the actual medical requirements is that blood types between giver and taker must be the same. This setup represents the blood type A (or B) and type AB. For type AB, a waiting patient can receive from any type; on the other hand, the one who is type A (or B) can take only from the same type or type O.

The organ allocation rule

There were 3 treatments in the experiment, which are first come, first served, rebate and priority treatments. We treated first come, first served as the control group because it is the status quo in many countries, including Thailand. Dividing rounds into round 1-15 and round 16-30, we rearranged the sequence of treatment to remove the order effect. A number of groups in each sequence of treatment was shown in Table 2.

Table 2: the number of groups

		rounds 16 - 30		
		control	priority	rebate
rounds 1 – 15	control	3	3	3
	priority	3		
	rebate	3		

In the first come, first served treatment, the longest waiting subject received the organ, given that her type aligned with the organ donated. In the case that there was more than one subject who had the same waiting period, we chose one subject randomly.

In the priority treatment, we made 2 waiting lists, one for donors and another for non-donors. The matching between organs and subjects started from the donor waiting list. The longest waiting subject was matched first and so forth. If the organ still remained, or it was not compatible with all subjects after exhausting the donor waiting list, it, then, brough to match with subjects in the non-donors list. It could be the case that a non-donor had been waiting longer than a donor but the donor had opportunity to receive prior. In other words, when donors needed an organ, they were placed in higher rank (priority) than non-donors.

The rebate allocation rule is close to the first come, first served treatment. The donors, however, are rewarded at the end of experiment. Ideally, the rebate should be the benefit of organ donation. Due to the fact that the donor was not able to receive her organ, her benefit was only from other's donation in the sense that the more donors, the more benefit she obtained because of increasing in chance to receive the organ. Therefore, the amount of rebate (or the benefit to be the donor) was determined by the number of donors. From this reason, subjects did not know the exact amount of the rebate during the experiment. They were informed only that the benefit depended on the number of donors. Otherwise, they would know the number of donors that subjects whereas in other treatments did not know this information.

Since the benefit from the priority and the rebate rule were different, we had to assure that both benefit is comparable. The benefit of the priority rule is the increasing in payoff that subjects received from longer life. The rebate scheme then, was calculated from the average of payoff from 100,000 simulations in priority treatment, when other donors were 0, 1, …, 11, respectively.

Figure 3. Rebate scheme.

Number of other donors	Rebate	
	Type X	Type Y
0	0	0
1	1.37	0.96
2	2.49	1.8
3	3.21	2.12
4	3.41	2.29
5	3.33	2.24
6	2.95	2.08
7	2.6	1.88
8	1.8	1.46
9	1.4	1.03
10	0.6	0.61
11	0.07	0.05

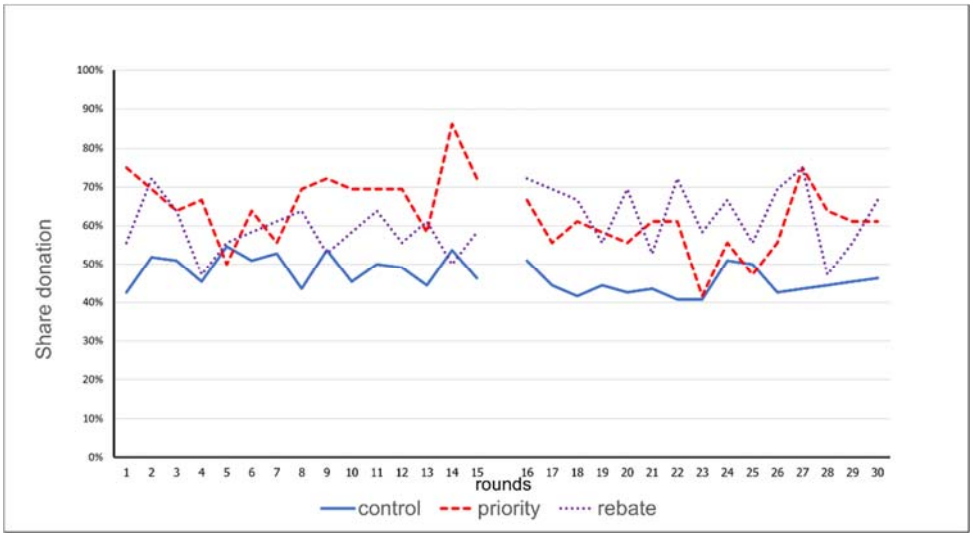
Since type X donors can certainly find matched organ, while type Y donors could be only matched 50% of the time, the benefit of being donor was higher, regardless the number of other's donation. In addition, the benefit of both types was inverted U-shape. It rose until 4 other's donations (5 subjects in total) and then decreased. The increasing in other's donation means that the organ was less deficient, and the advantage of priority depreciated. Note the priority benefit was zero, when no other's donation because the donor could not receive her organ.

5. Results

We conducted the experiment at the computer laboratory of the Faculty of Economics, Prince of Songkla University during October and November 2019. We recruited 180 subjects to participate in the experiment and all are Bachelor degree students of Prince of Songkla University. The average payoff was 286 Baht (inclusive of 150 Baht show up fee).

The average donation of all treatments is 53%. The average donation of priority and rebate treatment is higher than first come, first served treatment by 14 and16%, respectively. From Figure 4, the donation in first come, first served lowers than the other treatments. In rounds 1-15, there are only round 4 and 5 that the donation in control groups closes to other treatments. Similarly, the first come, first served and priority group closes together in round 23-25. We notice that the percentage of donation fluctuates around mean in all treatments, which is different from a pattern of contribution in public goods literatures. Particularly, the contribution is high in the early and gradually decline (for example, Ledyard (1994), Isaac and Walker (1988) and Andreoni (1988)). The reason of the fluctuation around the mean is that subjects in our experiment are challenged from the uncertainty in the organ compatibility and the status of brain and kidneys. With those unknowns, the benefit of donations is ambiguous.

Figure 4: Donation round by round



Applying the Wilcoxon rank-sum test, we find that the median between control and treatment groups is statistically different from the other treatments. In addition, the median between rebate and priority is different statistically in both 1-15 rounds and 16-30 rounds (see Table 3.).

Table 3: Wilcoxon rank-sum test

	rounds 1-15	rounds 16-30	rounds 1-30
control vs. rebate	11.99***	22.185***	24.52***
control vs. priority	21.16***	16.066***	25.85***
rebate vs. priority	10.29***	-5.607***	3.44***

***indicates 1% significant level, ** indicates 5% significant level, * indicates 10% significant level

In addition, we confirm non-parametric statistics by performing regression analysis. Although the data from the experiment is panel data in which a cross section unit is subjects and time unit is rounds, we apply pooled OLS regression. The panel model is

$$y_{it} = \boldsymbol{x_{it}}\boldsymbol{\beta} + c_i + u_{it}$$

, where c_i is individual heterogeneity. We choose pooled OLS rather than fixed or random effect because all independent variables ($\boldsymbol{x_{it}}$) are dummy variables which is purely exogeneous. In addition, we exclude subjects' background which is a key factor of individual heterogeneity; for example, we use neutral words "goods A" and "goods B", instead of "brain" and "kidneys". In other words, we have $E(\boldsymbol{x'_{it}}u_{it}) = 0$ and $E(\boldsymbol{x'_{it}}c_i) = 0$ by experimental design. We therefore treat $v_{it} = c_i + u_{it}$ as an error term and the estimated value of pooled OLS regression is consistent.[8] Since c_i is constant over time and the error term v_{it} has serial correlation problem, we apply robust variance matrix in all models when calculating a standard error.[9]

[8] See detail in Wooldridge (2010) pp. 256-257.
[9] See detail in Wooldridge (2010) pp. 171-176.

Table 4: Marginal effect of Probit model.

	regression 1	regression 2	regression 3	regression 4
priority	0.158 (0.027)***	0.181 (0.038)***	0.227 (0.045)***	
rebate	0.138 (0.028)***	0.093 (0.046)**	0.08 (0.048)*	0.027 (0.051)
second half		-0.041 (0.03)	-0.041 (0.03)	-0.087 (0.029)***
second half*priority		-0.049 (0.065)	-0.049 (0.065)	
second half* rebate		0.091 (0.074)	0.090 (0.073)	0.132 (0.071)*
type			0.086 (0.038)**	0.057 (0.035)
type*priority			-0.103 (0.053)*	
type*rebate			0.028 (0.056)	0.042 (0.058)
earning last round				0.021 (0.000)**
received an organ last round				0.039 (0.018)**
N	5400	5400	5400	5,220
Wald Chi 2	49.93	52.68	65.61	42.17
Psuedo R2	0.016	0.019	0.023	0.0173

The coeficient is marginal effect of probit model and parenthesis is in standard error. This estimate is calculated by cluster by id.
***indicates 1% significant level, ** indicates 5% significant level, *indicates 10% significant level

Table 4 demonstrates between-subject effect by estimating 4 Probit models.[10] The dependent variable in all models are donations, which is 1 if subjects donate. In regression 1, the coefficients of marginal effect of *rebate* and *priority* variables are positive and statistically significance. The priority and rebate allocation rule outperform the first come, first served in the sense that subjects in those rules are more likely to donate about 13.8-15.8, compared with subjects in the first come, first serves rule. This result is consistent with the significance of Wilcoxon rank sum test. The statistics are 25.85 (p-value = 0.000) and 24.52 (p-value = 0.000) for priority and rebate treatments, respectively.

[10] Table 4 shows In addition, we run Logit model and Linear Probability model (LPM) and results are same as Probit model. However, some observations in LPM return the probability greater than 1 ($\hat{y}_{it} > 1$).

Although organ receiving is a private goods, registering organ donation is a public goods in first come, first served rule. It is non-rival because everyone benefits from registering and it is non-excludable because everyone who has been waiting longest and can match to a donors' organ can be a receiver. By contrast, it is still non-rival in priority rule but non donors are excluded from the organ pool, especially when the organ is scarce. In other words, registering is club goods in priority allocation rule. That is the reason of higher donors in priority rule than first come, first served rule.

In addition, we find that the difference in probability of donation between priority and rebate rule is significant statistically. With the significant level of 1%, the chi-square statistic is 49.93 (p-value = 0.000). This result is from the difference in information structure. In priority rule, if a donor does not receive an organ, it is more likely that no one donate in that round. If someone donates, she has high opportunity to receive the organ because of the priority. This fact implies the number of others' donation in each round. By contrast, not receiving is more vague in rebate treatment. It might be because no one donates or because someone takes the organ instead of her. Donors will know about others' donation when they receive rebate at the end of experiment. Therefore, donors have more information about others' donation in priority rule than in rebate rule. This result implies that a subject donates when she knows that other subjects donate. It is consistent to the "conditional cooperation", which is first introduced by Fischbacher et. al (2001).

Regression 2 additionally controls the effect of rounds 1-15 and 16-30. The *second half* variable is 1 if observations are from rounds 16-30. In addition, we add interaction effects between the effect of round and organ allocation rule. However, all coefficients are not significant. It means that sequence of playing does not affect donation probability. This result is not consistent to the literature such as Kesler and Roth (2012), Li et.al (2013)

In regression 3, we investigate the effect of organ compatibility. The *type* is a binary variable which is 1 if observations are from subjects who can match any type of donors. The coefficient of *type* variable is positive and statistically significant. Subjects who have 100% organ compatibility are 8.6% more likely to donate than subjects who have 50% compatibility. However, the coefficient of interaction term between type and priority is negative significantly. It turns out that subjects who have 100% compatibility donate lower in priority rule.

Regression 4 investigates the effect of the benefit in the last round to donation probability. We add *earning last round* and *received an organ last round* variables. However, we remove variables which involve priority rule because subjects might decide to donate, based on the benefit she receives from the last round. Unless leaving those variables, the model might have a collinearity problem. The coefficient of *earning last round* is positive and significant. A subject increases donation probability when she receives more payoff in the last round. Similarly, the coefficient of *received an organ last round* variable is positive and significant. Receiving an organ in the last round increase the donation probability about 4%. This result confirms "conditional cooperation" behavior of donors.

6. Conclusion.

This paper investigates the effect of organ allocation rules aiming to increase organ donation. We find that people decide to donate subject to the allocation rule. The probability of donation in rebate and priority rule is clearly higher than in first come, first served rule (status-quo). Furthermore, organ compatibility factors such as blood type is crucial. Subjects who can easily match to organs are more likely to donate.

Although rebate rule can increase the donation rate, it is difficult in practice. Giving money to donors is close to selling and buying organ which is constrained by law and moral reasons. Roth (2007) called this trade as repugnant market. Deducting tax is alternative form of rebate scheme and it is currently applied in some states of the USA such as New England.

The priority allocation rule is currently in some countries such as Israel, Singapore, USA. In particular, the hospitals in USA collaborate to establish National Kidney Registry (NKR) to exchange kidneys among members and living donors. NKR follows the matching algorithm of Roth et. al (2004), Roth and Sönmez (2005) and Roth et.

al (2005) to match donors' organ and patients who registers to the center. Ghanbariamin and Chung (2020) find that in NKR center, the registered patients who has priority spend less time for kidney transplantation than non-registered patients do. Although this center is applied for only living donors, we belief that it can be applied to deceased donors.

Another policy options to raise organ donation is changing the default option from opt-in to opt-out. For example, Singapore assign citizens to be donors by default but they can register to be non-donors. In countries which apply opt-out option, the donation rate is much higher than opt-in option countries. In other words, the majority of people do not change the default option. The explanation is that they think the government has already assigned the appropriate choice.

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