

Organ Allocation Policy and the Decision to Donate^{*}

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ABSTRACT

Organ donations from deceased donors provide the majority of transplanted organs in the United States, and one deceased donor can save numerous lives by providing multiple organs. Nevertheless, most Americans are not registered organ donors despite the relative ease of becoming one. We study in the laboratory an experimental game modeled on the decision to register as an organ donor, and investigate how changes in the management of organ waiting lists might impact donations. We find that an organ allocation policy giving priority on waiting lists to those who previously registered as donors has a significant positive impact on registration.

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I. Introduction

The majority of transplanted organs in the United States come from deceased donors, whose organs are transplanted into patients following the donor's death.¹ Despite the need for organs (over 100,000 patients are currently awaiting organ transplants in the United States²) and the ease of registering as a donor (a few clicks on a website or checking a box when getting a driver's license), only 37.1% of individuals over the age of 18 in the United States are registered as organ donors.³

Changes in organ allocation procedures can influence the supply of transplantable organs. One line of research, concerning kidney exchange among incompatible patient-donor pairs, has investigated how matching mechanisms for *live* donors can increase the number of kidney transplants (Roth, Sonmez and Unver 2004, 2005a,b, 2007; Roth et al. 2006; Saidman et al. 2006), and has led to a number of new practices and institutions.⁴ Kidney exchanges match incompatible patient-donor pairs to other incompatible patient-donor pairs, allowing for exchanges and for chains of donation that start with an undirected donor.⁵ Despite a growing (but still small⁶) number of transplants resulting from kidney exchange, the kidney waiting list has continued to grow and shows no signs of slowing down. For kidneys in the United States, Table 1 lists the number of donors, transplants, and the number of people on the waiting list. Kidneys have longer waiting lists than other organs because dialysis can keep patients in need of kidney transplants alive for a time while waiting, but the need for other organs is great as well, and patients who do not promptly receive a transplant often die while waiting.

¹ Based on OPTN data as of Dec. 8, 2010 (see <http://optn.transplant.hrsa.gov/latestData/rptData.asp>).

² For example, over 87,000 are on the waiting list for a kidney. Waiting list numbers are based on OPTN data as of Dec. 8, 2010.

³ Based on the Donate Life America *National Donor Designation Report Card 2010* (which can be found at http://www.donatelife.net/pdfs/DLA_Report_Card_2010_FINAL.pdf).

⁴ For example, the New England Program for Kidney Exchange (NEPKE) and the Alliance for Paired Donation (APD). Following the passage of new federal legislation in 2007, plans are underway for a national exchange, which ran an initial pilot match in October 2010.

⁵ Because a broken chain is less costly if it begins with a non-directed donor, it was proposed in Roth et al. (2006) that such chains could be performed non-simultaneously. The first non-simultaneous chain that began with an undirected donor was begun in 2007 and continued over a period of 8 months and resulted in 10-transplants (Rees et al. 2009). Donor chains beginning with an undirected donor are becoming more common (see <http://marketdesigner.blogspot.com/search/label/chains>).

⁶ There were 34 transplants due to kidney exchange in 2004, the year NEPKE was founded, and there were 240 in 2008, and 304 in 2009 according to data reported to the Organ Procurement and Transplantation Network (see <http://optn.transplant.hrsa.gov/latestData/rptData.asp>, as described in <http://marketdesigner.blogspot.com/2010/05/kidney-exchange-time-series.html>).

In addition, economists and others have discussed the possibility of cash markets for organs, in which kidneys could be bought and sold to address the current excess demand for kidneys. Proposals to introduce monetary payments for organs are constrained by concerns about the morality and ethicality of such practices, and *repugnance* towards cash markets for organs limits their feasibility, at least for now (Roth 2007; Leider and Roth 2010).⁷

Table 1: U.S. Kidney Transplants

Year	Deceased		Living Donors	All Wait-list Patients	New Wait-list Additions
	Deceased Donors	Donor Transplants			
1999	5,386	8,044	4,725	41,176	21,845
2000	5,489	8,126	5,499	44,568	22,356
2001	5,528	8,233	6,042	47,576	22,502
2002	5,638	8,539	6,240	50,301	23,631
2003	5,753	8,667	6,473	53,530	24,683
2004	6,325	9,358	6,647	57,168	27,280
2005	6,700	9,913	6,571	61,562	29,145
2006	7,178	10,661	6,435	66,352	32,361
2007	7,240	10,591	6,043	71,862	32,424
2008	7,188	10,552	5,968	78,366	32,584
2009	7,248	10,442	6,389	84,244	33,671

The data for years 1999–2009 are provided by OPTN as of May 21, 2010. New Wait-list Additions counts patients (rather than registrants) to eliminate the problems of counting multiple times people who register in multiple centers. All Wait-list Patients also counts patients rather than registrants. All Wait-list Patients data from 1999-2007 are from the *2008 OPTN/SRTR Annual Report*; All Wait-list Patients data from 2008-2009 are extrapolated from Wait-list Additions and Waitlist Removals provided by OPTN as of May 21, 2010.

Here we focus on deceased donation and mechanisms to increase the number of individuals registering to be organ donors (individuals who agree to donate those of their organs

⁷Kidney sales are a contentious issue. Leider and Roth (2010), in an article called “Kidneys for Sale: Who Disapproves and Why” in the *American Journal of Transplantation*, reported a survey of opinions of a representative sample of Americans. It was published with an accompanying editorial (Segev and Gentry 2010) called “Kidneys for Sale: Whose Attitudes Matter?” which offered the opinion that it is a waste of resources to survey public opinion, since only the opinions of physicians matter, and physicians are against organ sales. Subsequent letters by physicians (Matas 2010; Satel 2010) disagreed strongly and reflected the wide range of opinions on this subject even among physicians and surgeons (see also Danovitch and Delmonico 2008 against sales; Matas, Hippen and Satel 2008 for donor compensation). See also Becker and Elias (2007) on the case for organ sales.

that are usable in the event of an untimely death).⁸ Deceased organ donation is a natural place to focus attention since the registration rates for organ donation are rather low (37.1 percent nationally and, for example, only 13 percent in New York, the third most populous state).⁹ Since next of kin can provide consent for donation at time of death, donation rates of eligible deceased donors are higher than registration rates, although they are still well below 100 percent. In addition, the gains to generating more deceased organ donors are substantial: one deceased donor can provide multiple vital organs (including kidneys, liver, heart, pancreas, lungs, and intestine) as well as tissues (including corneas, skin, heart valves, cartilage, bone, tendons, and ligaments). Finally, while exchanges and donor chains can increase the number of transplanted kidneys, there is essentially no possibility of live donation for other solid organs such as the heart, pancreas, and intestine, and not much transplantation of live donor lungs or livers. Live donation of blood and of bone marrow is very feasible, and has been the subject of considerable study. (Recent work on blood donation has investigated whether payments for blood donors can be effectively used to increase donations, or whether the donations suffer from a “crowding out” (see Lacetera et al. 2009; Mellstrom and Johannesson 2008).¹⁰ Research on bone marrow donations by Bergstrom et al. (2009, 2010), Fève and Florens (2005), and Fève et al. (2007) argues that fewer individuals are on the bone marrow registry than is optimal.)

In this paper we consider deceased organ allocation policies that give priority for receiving organs to people who are themselves registered donors (and have been registered for some time). Such policies provide an incentive for registering to be an organ donor. This kind of donor-priority system is in use in Singapore (since the 1986 passage of their Human Organ Transplant Act¹¹) and is being implemented in Israel (following passage of a 2008 organ

⁸ Some recent work has focused on deceased donation, in particular on the production chain that gets deceased donation organs to recipients. The work uses Spain as an example, considers transplantable organs as a public good, and suggests that more efficient processes can increase the number of organs transplanted (Deffains and Ythier 2010).

⁹ Based on the Donate Life America *National Donor Designation Report Card 2010* (which can be found at <http://www.donatelife.net/donante/DLA+Report+Card+2009.pdf>).

¹⁰ Both Lacetera et al. (2009) and Mellstrom and Johannesson (2008) investigate the hypothesis of Titmuss (1970) that paying for blood donation might crowd out the altruistic reasons for giving and lead to less donation. While Mellstrom and Johannesson (2008) find evidence of crowding out in a field experiment on blood donation in Sweden, Lacetera et al. (2009) do not find crowding out on blood donations from observational data and a field experiment in America.

¹¹ The Human Organ Transplant Act can be found at <http://www.moh.gov.sg/mohcorp/legislations.aspx?id=1672>

transplant law¹²). Singapore has an opt out system, in which everyone is by default a donor in the national registry, and any citizen or permanent resident of Singapore who opts out of being an organ donor gets lower priority for deceased donor organs in the event that they need one.¹³

Israel has an opt in system, in which (once the system is fully implemented) anyone who has registered to be a deceased donor at least three years earlier will receive priority. Such donor-priority policies generate an incentive for becoming a donor within the organ donation system and do not require additional incentives from outside of the system. A related approach is being attempted in the U.S. by a private club called Lifesharers, which prioritizes deceased donations of organs by its members to its members who need them. Lifesharers is not part of the national allocation system, so it requires individuals to opt into the club in addition to registering as a donor, and gives priority access to only those organs donated by members of the club.¹⁴

This paper investigates incentives to donate by means of an experimental game that models the decision to register as an organ donor. The main manipulation is the introduction of a priority rule, inspired by the Singapore and Israeli legislation, which assigns available organs first to those who had also registered to be organ donors. Another experimental condition replicates the incentive effects of the priority rule (in expectation) but provides organs by a standard waiting list. A final condition institutes a simple discount in the cost of agreeing to be an organ donor.

Results from our laboratory study suggest that providing priority on waiting lists for registered donors has a significant positive impact on donation.¹⁵ We are able to replicate most of the benefit with a rebate that provides the same incentive for donating as priority, and with a discount in the cost of donation, although only when they are introduced after the subjects have

¹² The proposed Israeli policy gives priority to the individuals and family members of those who have signed donor cards or made live organ donations (news stories can be found at <http://www.medicalnewstoday.com/articles/174514.php> and <http://www.jpost.com/HealthAndSci-Tech/Health/Article.aspx?id=195354>).

¹³ One strategy discussed for increasing registration rates in the United States is to change to an opt out system in which those who take no action are assumed to be donors at death, as in Singapore, Spain (which has the highest rate of deceased organ recovery), and other European countries (most of which have lower rates of organ recovery and transplantation than the United States). This policy is an interesting and important one to consider but may have legal consequences that make it less effective at increasing final donation rates than increasing registration rates. We discuss this again in the discussion.

¹⁴ As of December 2010, Lifesharers' membership is less than 15,000 and there has not yet been a transplant on the Lifesharers network (see <http://www.lifesharers.org/>).

¹⁵ In our experiment, registration results in donation whenever the registered organ donor becomes deceased and a recipient is available. We will discuss in the conclusion some of the legal and practical gaps between registration as an organ donor and successful donation and transplantation.

made donation decisions a number of times. When the policies are introduced at the start of the game, the priority rule outperforms an equivalent change in the cost of donation.

It may be helpful to pause for a moment and think about what kinds of hypotheses relevant to organ donation can be investigated in a laboratory experiment that does not involve actual organ donation decisions. While there are obviously important questions related to organ donation that *cannot* be studied in the abstract, there are also important aspects of the actual organ donation decision that cannot be reliably or systematically manipulated, but which *can* be manipulated in the lab.

To see both sides of this, consider the issues that arise in modeling in the laboratory the costs associated with the decision to donate an organ after death. The costs of registering to be an organ donor are difficult to identify and to manipulate in the field. These costs may include worries that doctors will not work as hard to keep organ donors alive or that organs will be removed prematurely, and there may be visceral issues in thinking about actual organ donation such as discomfort in thinking about one's own death. In the laboratory, monetary costs can be imposed and manipulated, to model to some level of approximation the costs experienced by donors. And since compensation for donation is not allowed by United States law,¹⁶ cash rebates or cash transfers are not possible for actual organ donation decisions, so conditions that manipulate the net costs of registering as an organ donor with cash payments can only be run in the laboratory.

So in the laboratory we do not use real organs, but we impose real costs. The cost of registering to be a donor in the experiment is imposed and denoted in dollars (it decreases cash payment from the experiment). We take advantage of the opportunity to manipulate the cost of donation by running two conditions (discount and rebate) that decrease the costs of registering to be a donor to better understand why the priority rule generates an increase in the number of donors. While a donor-priority rule can be implemented in the world and in the lab, cash rebates and discounts cannot be implemented outside of the lab, but they allow us to test hypotheses about which features of the priority rule are responsible for increasing registration rates in the lab.

¹⁶ The National Organ Transplant Act of 1984 states, in part: "it shall be unlawful for any person to knowingly acquire, receive or otherwise transfer any human organ for valuable consideration for use in human transplantation." (Section 301, National Organ Transplant Act (NOTA), 42 U.S.C. 274e 1984)

While organ transplantation is a private good—only one person can receive each organ—it is useful to think of the organ donor *registry* as resembling a public good, since *ex ante* the pool of registered organ donors provides organs for the pool of potential recipients (which is currently not excludable). Even though an individual who is a deceased organ donor will not get to be an organ recipient, a larger pool of potential donors benefits everyone, including potential donors who end up needing organs rather than providing them. In other words, registering to be an organ donor resembles a public good *ex ante* that is a private good *ex post*.¹⁷ It may be that the donor-priority organ allocation policy increases registration rates in part because the allocation rules allow for non-donors to be excluded (or to have a smaller probability of receiving an organ), effectively turning the registry into a club good and generating an incentive to become a donor. We investigate the impact of this incentive in a simple model in Section IV.¹⁸

Our laboratory environment allows us to study the incentive issues involved in this type of public good, abstracted away from the important but complex sentiments and institutional details associated with actual organs. Results suggest that rewarding contributors with first access to the *ex post* private goods generated by the *ex ante* public good—by transforming the public good into something more like a club good—may generate increased contribution in public good environments of this form.

For our specific application, of organ registration and subsequent transplantation, results suggest that allocation policy may be a powerful tool to generate higher rates of deceased organ donation. A donor-priority rule provides a benefit for those registering as organ donors and does so in a way that is easy to understand.

II. Experimental Design

In the experiment, subjects made a decision modeled on the decision to register as an organ donor. In the experiment there is no difference between registering (in advance) to donate

¹⁷ The organ donor registry is rival (or congestible) in that the more people who take advantage of the pool of organs make it less likely another person is able to take advantage of it, but this characteristic is shared by other non-excludable goods (i.e. public parks, roads, and bridges) that are commonly thought of as public goods.

¹⁸ Unlike other games in the experimental literature on excludible public goods (for examples see Swope 2002; Cinyabuguma, Page and Putterman 2005; and Ahn, Isaac and Salmon 2009) our game does not fully exclude non-contributors from accessing the public good but instead provides priority to those who contribute. Instead, different potential recipients have different shares in the public good, in the sense that different priorities may give them different probabilities of drawing from the public good if need arises. In particular, non donors receive a smaller probability of access to the public good.

and being an available donor at death, and we will refer to this decision in the experiment as “donating”. The description of the experiment in the instructions to subjects was stated in abstract terms, not in terms of organs. Subjects started each round with one “A unit” (which can be thought of as a brain¹⁹) and two “B units” (representing kidneys²⁰). Each subject earned \$1 in each period in which they had both an active A unit and at least one active B unit (representing a flow of utility from being alive and healthy). Each period, the subject’s A unit had a 10% probability of failing and the B units had a 20% chance of failing (like kidneys, both B units operated or failed together).

Before making the donation decision in the first round, all subjects were informed that each round began with the subject having \$2 and consisted of a number of periods in which they could earn more money. Whenever a subject’s A unit failed, he lost \$1 and the round ended for him (representing brain death). When a subject’s B units failed, he had up to five periods to receive a B unit from someone else (representing dialysis, during which time he did not earn any money), if a subject did not receive a B unit in those five periods, he lost \$1 and the round ended for him (again representing death). Subjects could receive a B unit from another player in a given period if that player’s A unit failed in that period while his B units were still active, if and only if the player had agreed to donate his B units at the start of that round.

Subjects made a donation decision 31 times in a fixed group of 12 subjects. Subjects were not informed of the number of times they would make the decision but were told they would be paid for four randomly selected rounds. The donation decision was always asked at the start of the round, before any periods had passed, so subjects made the donation decision before knowing whether their A unit or B units would fail first.

Subjects were randomly assigned at the beginning of the game to either have low cost of donation or high cost of donation (such that each group of 12 subjects had 6 low cost donors and 6 high cost donors) and were only informed of their own cost of donation. Low cost donors had

¹⁹ In the United States, a patient is declared dead when his brain ceases to function (“brain death”) or when there is an irreversible loss of circulation (“heart death”). Most organ donation follows brain death, since the deceased patient’s organs can be kept alive while the patient remains connected to a respirator. In some other countries a patient is declared dead when his heart ceases to function. For example, in 2009 Japan passed legislation recognizing death at the time of brain cessation, previously only heart death had been recognized (news story can be found at <http://www.bloomberg.com/apps/news?pid=20601101&sid=ajgBoFtYJFKI>). Under laws requiring heart death for organs to be donated, an “A unit” could represent a heart.

²⁰ The B units could also represent other organs that are donated at the time of death, but it is easiest to think of B units as kidneys.

to pay \$0.40 so that their B units would be given to other subjects in the event that they had A unit failure (subjects who agreed to be donors always paid the cost, regardless of whether they had A unit failure or B unit failure first, representing the psychological costs of donation incurred at the time of the decision to register as a donor). High cost donors had to pay \$0.80 for their B units to be donated in the event of A unit failure. Subjects remained high cost or low cost donors for the entire experiment.

All subjects were told that if they were a donor and their A unit failed first, each of their B units would be donated to a subject who had failed B units and was waiting for a B unit if such a subject was present in that period. In addition, they were told that B units could not be donated again in the same round (i.e. a donated B unit could not be donated again after the failure of the recipient's A unit). After making the donation decision, subjects watched their outcome for each period of that round and were able to observe if any of their units failed in that period, how many periods they were waiting for a B unit, whether they received a B unit in that period, and how much money they had earned so far in that round of the game. After a subject could not earn any more money in a round, he stopped receiving information each period and he waited for the next round to begin. Subjects received no information about either the donation decisions or earnings of other subjects, and subjects were not informed if B units they donated were actually provided to other subjects (i.e. they did not know whether a subject needed a B unit in the period in which their A unit failed).

There were 4 different conditions under which subjects made donation decisions in the experiment. In the *control* condition, subjects were informed that donated B units were provided to those who needed B units in the order that those subjects had been waiting for B units: so subjects who had been waiting 5 periods would receive an available B unit before a subject who had been waiting 4 periods and so on.²¹

In the *priority* condition (motivated by the donor-priority rules in Singapore and Israel), subjects were informed that those who agreed to be donors at the start of the round would be given priority should they need to receive a B unit, and that B units would be provided first to subjects who had agreed to be donors, and only if no donors were in need of B units would B units be provided to subjects who were not donors. Within each priority group, B units were

²¹ If multiple subjects had been waiting the same number of periods and there were not enough B units for all of them, the B units were assigned randomly among the subjects who had been waiting the longest.

assigned by the length of time subjects had been waiting for B units with those who were waiting the longest getting available B units first. The priority condition generated an incentive for donating, the value of which depended on the number of other subjects who registered as donors. As long as at least one other member of the group donated, donors were more likely than non-donors to receive a B unit if they needed one. In addition, in the priority condition, registering as a donor provided a relatively strong positive externality on other donors since they are more likely than non-donors to receive donated B units.

In the *rebate* condition, B units were assigned as in the control condition, but subjects were informed that those who paid to be a donor would receive a rebate at the end of the experiment based on the number of other subjects in their group who also agreed to be donors. This treatment was meant to reproduce the incentive effects and the externality effects of the priority condition without affecting the allocation of B units. This treatment was run to investigate whether the priority rule was changing behavior as a result of allocating the B units differently (and penalizing the non-donors with lower access) or whether the difference was due to the incentive in terms of higher payout of having priority and simultaneously rewarding other donors. The rebate amounts were selected to be the expected value of receiving priority in the priority condition of the experiment. The rebate consequently depended on the number of other donors (just as the benefits of priority depend on the number of other donors and how many others in need of B units also have priority). The rebate amounts were the expected benefit of having priority given the probability of A unit and B unit failure in the experiment. The rebate was weakly increasing and concave in the number of other donors in that round. Subjects received no rebate if they were the only donor and received up to \$0.46 if 10 or 11 other subjects in their group were donors in that round.²² This meant that at the time of the donation decision, the private incentives in the rebate condition matched the private expected value of the incentives in the priority condition. Like being a donor in the priority condition (in which B units are more

²² The expected value of receiving priority was calculated by simulating one million rounds of the game for each number of donors from 1 to 12 and estimating the earnings of subjects who were given priority and those who were not conditional for each number of donors. The rebate profile was: \$0 for 0 other donors, \$0.10 for 1 other donor, \$0.20 for 2 other donors, \$0.28 for 3, \$0.33 for 4, \$0.37 for 5, \$0.40 for 6, \$0.42 for 7, \$0.44 for 8, \$0.45 for 9, \$0.46 for 10 or 11 other donors. Note that the return to donation is increasing in the number of other donors up to 11, reflecting that with these parameter choices there remains a shortage of kidneys even when all possible donors are registered. (If there were excess kidneys, so that the queue was always empty, priority on the queue would no longer be valuable.)

likely to go to other donors) being a donor in the *rebate* condition had a relatively strong positive externality on other donors.

In the *discount* condition, B units were assigned as in the control condition, but all subject costs were \$0.35 lower than in the control condition, so low cost donors paid \$0.05 to donate their B units and high cost donors paid \$0.45 to donate their B units. The \$0.35 discount approximates the expected value of the incentive for donation achieved by the priority rule (i.e. the amount paid to donors in the rebate) if 5 to 6 donors are contributing in a round.²³ This treatment was run to investigate whether the behavior change due to the priority rule could be replicated by a discount alone, simply offsetting the costs of donation and not generating the positive externalities to other donors.

Table 2: Number of Groups (Subjects) in each order of conditions

	Condition in second set of rounds (Round 16-31)				
Condition in first set of rounds (Round 1-15)		Control	Priority	Rebate	Discount
	Control	3 Groups (36 Ss)	8 Groups (96 Ss)	5 Groups (60 Ss)	4 Groups (48 Ss)
	Priority	4 Groups (48 Ss)	No Groups		
	Rebate	4 Groups (48 Ss)			
	Discount	4 Groups (48 Ss)			

Subjects were not told how many rounds they would play the game, but all subjects played 15 rounds in one of the conditions followed by 16 rounds in another condition. All subjects played the *control* condition either for the first 15 or last 16 rounds (36 subjects, in three groups, played the *control* condition in all 31 rounds to test for a restart effect). After the first 15 rounds, subjects were informed that the rules of the game had changed and any changes in the game were explained. Three groups of subjects who had played the first 15 rounds in the control condition were stopped after round 15 and told that there were no changes in the rules of the game. After round 30, all groups were interrupted and told that they would play the game one

²³ Since the average donation rate across all rounds of the discount condition turns out to be 55.4% (implying an average of 6.65 donors per round), this \$0.35 discount turns out to be remarkably similar to the rebate donating subjects would have received if they had been in the rebate condition and the benefit from donating they would have received from donating in the priority condition (in expectation).

final time (in the same condition they had been playing for the past 15 rounds). The number of groups who played in each of the orderings of conditions is displayed in Table 2.

After all rounds had been played, subjects were informed of which 4 rounds had been randomly selected for payment and were informed of any rebate earnings in those rounds (if subjects played in the *rebate* condition). All subjects were paid in cash at the end of the experiment.

III. Results

The experimental results are from 384 subjects who participated in the experiment in 32 groups in one of 23 sessions in the Spring and Summer of 2009.²⁴ Subjects were students at Boston-area colleges and universities. The experiment lasted up to one and a half hours and average earnings were \$25.87 per subject, including a \$10 show up fee. The experiment was conducted using z-Tree 2.1.4 (Fischbacher 2007).

Figure 1 displays the results across all sessions. The graph displays the percent of subjects who were donors in each round of the game for each condition (again for exposition, we will refer to registering as an organ donor as “donating” or “being a donor”). The break in the lines after round 15 represents the break in play during which groups may have been switched into one of the other conditions. Twenty groups played in the control condition for the first 15 rounds of the experiment and then either switched to one of the three other treatment conditions (17 groups) or stayed in the control condition (3 groups). The other twelve groups played one of the three treatment conditions for the first 15 rounds and then switched to the control condition for the last 16 rounds. Consequently, for the first 15 periods of the game the control line represents the 20 groups who made donation decisions in the *control* condition—these groups went on to all four of the conditions in the second 16 rounds. For the last 16 periods of the game, the control line also represents the 15 groups who made donations in the *control* condition (aggregated from the groups that, in the first 15 periods, were in any of the four conditions).²⁵

²⁴ Subjects played in groups of 12 in sessions of either 12 or 24 subjects. When two groups played simultaneously, they received the same order of conditions so all instructions (except for the costs of donating, which differed between subjects) could be read aloud.

²⁵ There were no significant differences in donation in the control condition in the last 16 rounds of the experiment between groups that played in the four different conditions in the first 15 rounds of the experiment.

Figure 1: Share Donating by Round

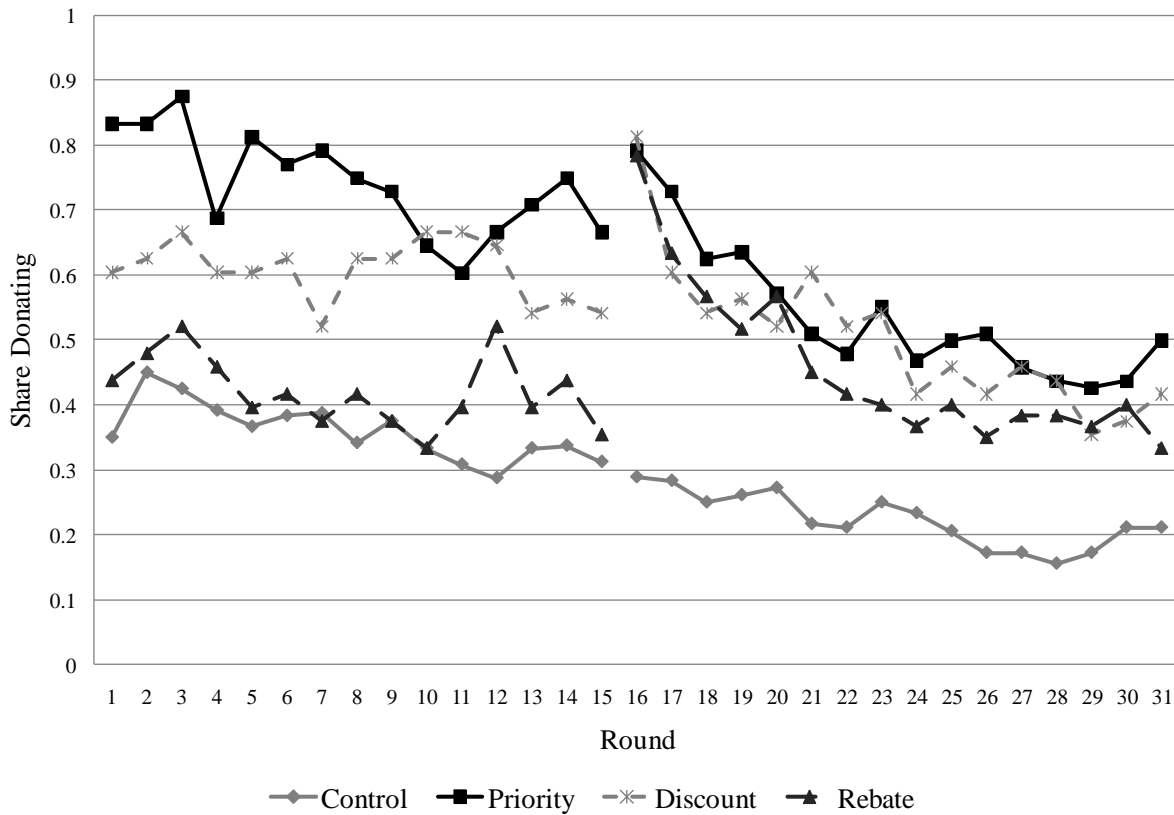


Figure 1 suggests that the *priority* condition had a significant positive impact on donation rates, starting in the first round in which it was implemented (either round 1 or round 16). In round 1, organ donation rates averaged 83.3% for the *priority* condition and only 35% percent for the control condition. In round 16, organ donation rates averaged 79.2% for the *priority* condition and only 28.9% percent for the control condition. Averaging across the first 15 rounds of the game, the *priority* condition averaged a donation rate of 74.2% while control condition averaged a much lower donation rate of 35.9%. Over the last 16 rounds of the game, *priority* averaged 54.0%, while *control* condition averaged a much lower donation rate of 22.3%. That the donation rate in the *priority* condition is 2 to 2.5 times higher than the donation rate under the control condition suggests a significant impact of the allocation rules on donation decisions. No additional financial incentives were added to the donation decision, so the rule change increased donations at no additional cost, simply providing incentives for the donors in terms of a higher probability of receiving a B unit.

To investigate why the *priority* condition is so effective at increasing donation rates, we ran two additional treatment conditions that provide some of the incentive effects of the priority rule. Compared to the *control* condition, the *priority* condition provides an incentive to donate in terms of an increased likelihood of getting a B unit when it is needed, and it provides a relatively strong positive externality to other donors (since when a subject donates, other donors are more likely to reap the benefits).

The *rebate* condition captures these two effects, providing the same direct incentives for donating as the priority rule. The *rebate* condition directly replicates the extra earnings that accrue to donors in the *priority* condition (in expectation) and replicates the relatively strong positive externality on other donors (also in expectation). The rebate condition does not change organ allocation, however, and so does not penalize non-donors with decreased access to B-units.

The *discount* condition only provides a decrease in cost for donors relative to the *control* condition but does not provide positive externalities to other donors. The discount of \$0.35 means that in each round donation is still costly, even for the subjects whose initial costs of donation were only \$0.40, although much less costly than the *control* condition. The discount is provided to all donors but does not provide any positive externality to other donors.²⁶

Figure 1 shows that the *rebate* and *discount* conditions perform differently in the first 15 periods (when subjects play the treatment condition first) and the last 16 rounds (when subjects play the *control* condition for the first 15 periods). In the first fifteen rounds of the game, the *priority* condition generates significantly more contribution than the *discount*, *rebate*, and *control* conditions. In addition, the *discount* condition generates significantly more contribution than the *rebate* and *control* conditions (which cannot be ranked).²⁷ When implemented in round 16 of the game (after 15 rounds of the control condition), the *priority*, *rebate* and *discount* conditions all have similar effects (and all outperform the control condition).²⁸

That the *priority* condition performs so much better than the *rebate* when implemented at the start of the experiment is particularly striking when we consider that the rebate provides the

²⁶ The two treatment conditions (*rebate* and *discount*) that involve a decrease in the costs of becoming an organ donor should be seen as relative costs, since the psychological costs underlying the decision to become an organ donor are hard to measure. The lesson from these treatments is that lowering costs has a significant, positive effect on behavior.

²⁷ Probit tests on donation rate (without additional controls) and with standard errors clustered by subject find over the first 15 rounds that: Priority > Discount ($p=0.015$); Discount > Rebate ($p=0.003$); Rebate = Control ($p=0.205$).

²⁸ Probit tests on donation rate (without additional controls) and with standard errors clustered by subject find no differences between Priority, Discount and Rebate over rounds 16-31 ($p>0.1$ for all tests).

same incentives as the priority rule and that the rebate does just as well as priority after subjects have become familiar with the game by playing 15 rounds in the *control* condition. One reason that the priority rule might perform better than the rebate at the start of the game is the simplicity of the priority rule. The *discount* condition is also quite simple (subjects in the *discount* condition in the first 15 periods simply saw a lower initial cost of contributing) and donation rates in the *discount* condition are also significantly higher than in the *rebate* condition at the start of the game.

The simplicity of the priority rule may matter in part because private benefits of priority and the rebate condition depend on the number of other donors in a given round. Without experience in the game, subjects do not have information about the number of subjects who might choose to be donors (with experience, subjects get to see whether they receive a B unit when they need one). Consequently, without experience, subjects' beliefs about the number of other donors will be based much more on the rules of the game. Simpler rules may make a subject more likely to donate because the benefits are clearer to him or because he believes the benefits are clearer to other subjects who are more likely to donate, which generates a stronger incentive for him to donate.

Of the mechanisms that we examined in the lab, the *priority* allocation rule is the most effective at increasing organ donation rates when implemented at the start of the experiment and it is as effective when implemented after subjects have become familiar with the game. In addition, it is worth noting again that we can implement the priority rule outside of the lab, but we do not know how to decrease the psychological costs of registering to be an organ donor. Also, legal constraints prohibit the use monetary payments like cash rebates to compensate for registering to be an organ donor. We will discuss these issues in the conclusion.

Table 3 demonstrates the results from Figure 1 in a regression analysis, estimating the probability the subjects chose to be a donor in each of the conditions. In addition, Table 3 displays results about the between-subject effect of being a high cost donor. Finally, the random failure of A and B units in each round allows for a more-in-depth analysis of the motivations for being a donor across rounds.²⁹

²⁹ Table 3 reports linear probability models using OLS regression specifications with robust standard errors clustered at the subject level. The results are qualitatively the same whether we add session dummies, or cluster at the group level, or cluster by round. The results are also qualitatively the same if we include subject dummies (although this specification prevents estimation of between-subject variables that do not change over the course of the experiment,

The significant positive coefficients on *Priority*, *Rebate*, and *Discount* in regression (1) show that across all 31 rounds, subjects are 14 to 31 percentage points more likely to donate when they are in one of the three treatment conditions than in the control condition (representing roughly 50% to 100% more donations than the 30% donation rate in the control condition), results that are highly statistically significant. Including all of the rounds in the analysis in regression (1), *Priority* outperforms *Rebate* ($p < 0.01$) and *Discount* outperforms *Rebate* ($p = 0.017$), but *Priority* and *Discount* are statistically indistinguishable ($p = 0.254$).

Regression (2) separates the effect of the treatment into the first half and the second half by including a control *Second Half* that is equal to 1 in rounds 16 to 31 and is interacted with the treatment conditions. Donation is about 14% less likely in the second half of the experiment (*Second Half* is negative and significant). The positive coefficient on *Second Half*Rebate* represents the *Rebate* condition working particularly well in the second half of the experiment, after subjects have experience with the game from playing in the *Control* condition for 15 rounds. Using estimates from regression (2), we find that *Priority* outperforms *Discount* and *Rebate* in the first 15 rounds of the experiment but the three are indistinguishable in the second half of the experiment.

like the effect of having a high cost of donating). In addition, the results are qualitatively the same when we specify Probit rather than a linear probability model. While the linear probability model is inefficient, it is unbiased and we use robust standard errors to address the heteroskedasticity of the error terms. In addition, none of our specifications imply estimated probabilities less than 0 or greater than 1. The linear probability model is the primary specification since the regressions are meant to demonstrate the differential average effects across the treatments and since Probit specifications can introduce bias in estimates of interaction terms (see Ai and Norton 2003 explanation of the bias and a correction). We also estimated coefficients for each interaction using a Probit specification and the correction proposed in Norton, Wang and Ai (2004) and the coefficients are almost identical to those estimated by the linear probability model (i.e. all coefficient estimates are quantitatively similar and therefore we never estimate a different sign or a different level of significance from the linearly probability model when using the corrected Probit).

Table 3: Donation by Condition

	Linear Probability Model (OLS)			
	(1)	(2)	(3)	(4)
Priority	0.306 (0.029)***	0.383 (0.041)***	0.395 (0.048)***	
Rebate	0.143 (0.030)***	0.062 (0.050)	0.083 (0.058)	0.080 (0.059)
Discount	0.255 (0.034)***	0.249 (0.045)***	0.327 (0.055)***	0.321 (0.057)***
Second Half		-0.136 (0.028)***	-0.136 (0.028)***	-0.133 (0.028)***
Second Half*Priority		-0.066 (0.066)	-0.066 (0.065)	0.000 0.000
Second Half*Rebate		0.172 (0.081)**	0.172 (0.081)**	0.169 (0.081)**
Second Half*Discount		0.030 (0.077)	0.030 (0.073)	0.032 (0.074)
High Cost			-0.062 (0.031)**	-0.058 (0.031)*
High Cost*Priority			-0.025 (0.055)	
High Cost*Rebate			-0.042 (0.060)	-0.046 (0.061)
High Cost*Discount			-0.155 (0.063)**	-0.158 (0.064)**
Recipient Last Time				0.054 (0.019)***
Earnings Last Time				0.005 (0.002)***
Earned from Receipt Last Time				0.004 (0.004)
Constant	0.298 (0.016)***	0.359 (0.020)***	0.390 (0.025)***	0.359 (0.026)***
Observations	11904	11904	11904	9312
R-squared	0.07	0.09	0.1	0.07

Robust standard errors, clustered by subject are in parentheses: * significant at 10%; ** significant at 5%; *** significant at 1%

Independent Variables: Priority, Rebate and Discount are dummy variables representing the treatment; Second Half is a dummy variable equal to 1 for rounds 16 to 31; High Cost is a dummy variable equal to 1 if the potential donor faced the \$0.80 cost rather than the \$0.40 cost; Recipient Last Time is a dummy variable equal to 1 if the subject received a B unit in the last round; Earnings Last Time are earnings from the previous round (excluding the costs of donating); Earned from receipt last time represent the earnings associated with the receipt of a B unit in the previous round.

Regression (3) additionally controls for whether the subjects had randomly been assigned the high cost of donating (\$0.80) rather than the low cost (\$0.40). The coefficient on *High Cost* is negative and significant, suggesting that facing a donation cost that is \$0.40 lower makes subjects 6% more likely to donate.³⁰ The variable *High Cost* is also interacted with all three treatment conditions. The only significant coefficient on these interaction terms are for the *Discount* condition, which suggests that the *Discount* condition had a more significant impact on the low cost donors than on high cost donors. The *Discount* condition may have been particularly appealing for the low cost donors since the discount decreased the cost of donation to only \$0.05 each round for the low cost donors.

Regression (4) investigates the role of receiving a B unit in this round on donation in the following round. Receiving a B unit is the only way a subject can get positive information about the donation decisions of other subjects (if his A unit fails first, he does not see any information about the donations of others; if his B unit fails first and he never receives a B unit, he gets negative information about the number of people in his group that are donating their B units). Regression (4) excludes data from the *Priority* condition since the probability of getting a B unit in that treatment is correlated with the decision to be a donor. The coefficient on *Recipient Last Time* is positive and significant, suggesting that subjects are about 5% more likely to be a donor when receiving a B unit in the previous round. The higher probability of donation after receiving a B unit is driven in part by the positive news and in part due to the additional earnings of a subject who receives a B unit, since higher earnings in a previous round increase the likelihood of donating (*Earnings Last Time* is positive and significant). However, there is no additional increase in the likelihood of donation when the earnings came after a B unit was needed and received (*Earned from Receipt Last Time* is not significant).

IV. Simple Model

The experimental results demonstrate that the donor-priority rule had a significant positive impact on donation in the experiment. The priority rule provides an incentive for registration as an organ donor within the organ allocation system. To help interpret the effect of

³⁰ The estimate of 6% for the between-subject effect of lower costs is small relative to the within-subject effect of 26%, as estimated in regression (1) that results from a \$0.35 discount being implemented. This difference may be due to a difference in information. Subjects have only private information about own donation costs but information about the discount is made publicly, so subjects may infer changes in the donation behavior of others that reinforces their own donation decisions.

the priority rule, we develop a simple model to examine the equilibrium impact of introducing this incentive. In this model, we show how the impact of the priority rule depends on the probability of brain death (A unit failure) and probability of organ failure (B unit failure). Compared to the game subjects played in the experiment, the model makes three simplifying assumptions for analytical tractability.

First, the model collapses the game into two periods. The stochastic process by which A units and B units fail in the experiment is complicated, but it is not essential to understanding the effect of the priority rule. In the experiment, all subjects decide whether to donate before the first period of each round and so their decisions are made before they have received any information about the failure of their units or any information about their payouts. Thus, the stochastic process allows subjects to observe the period-by-period outcomes that generate the final payoff in the round, but each round has first a decision period followed by a payoff (accumulated over potentially many periods as determined by the stochastic process and donation decisions of other subjects). The model presented here collapses this into a two-period game. In the first period, subjects simultaneously make donation decisions, and all payoffs are revealed in the second period.

Second, we model the agents as a continuum rather than the 12-person groups used in the experiment. Usually when making this leap we need to take into account that in a small group an agent's contribution impacts his own payoff (while it does not in a continuum of agents). In our setting, however, a subject can never give himself an organ, and a subject's chance of receiving an organ is not influenced by his own donation decision (except in the priority condition). Consequently, in the laboratory experiment, as in a continuum of agents, a subject who donates does not increase his likelihood of getting a B unit when he needs one.

Third, the model assumes that all agents know the distribution of costs agents face for donating. As will be discussed below, this cost collapses the direct cost of donating and any altruism or positive feelings associated with making a donation, which means the cost can be negative. In the laboratory experiment, subjects only know their own monetary cost of donating (\$0.40 and \$0.80 as randomly assigned by the experiment) and not the distribution of these costs.

To summarize, we model the decision to register as an organ donor as a two-period game. In the first period, a continuum of agents decide whether to register as an organ donor. In

the second period, agents realize their health states, their organ outcomes (whether they receive an organ if they need one), and their payoffs.

An agent's health state is either: (1) dead from brain death (and in a position to donate an organ if the agent had registered as an organ donor) which occurs with probability $\beta > 0$, (2) in need of an organ (we assume that everyone who needs an organ needs only one) which occurs with probability $\theta > 0$, or (3) neither which occurs with probability $1 - \theta - \beta \geq 0$. If an agent is in need of an organ, he also realizes his organ outcome. He either: (1) receives an organ (for simplicity all donated organs are treated as identical) or (2) does not receive an organ. The number of organs made available by the brain death of an agent is α , and the probability of receiving an organ depends on the decisions of other agents in equilibrium.

The first part of the payoff is associated with an agent's health and organ outcome. This part of the payoff is normalized to be 0 when the agent is in need of an organ and no organ is received, and the payoff is normalized to be $V > 0$ when an agent is in need of an organ and receives one. The payoffs for all other states of the world are unrestricted, since they never enter the decision problem.

The second part of the payoff is the cost associated with registering as an organ donor, which is additively separable from the payoffs from health and organ outcomes. Agents incur a cost of registering as an organ donor c that combines the direct costs of registering (for example, fear of worse medical treatment or discomfort the agent feels from thinking about his own death) with the benefits of being a donor (for example altruism or warm glow from registering as a donor). We assume a continuum of agents with cost of donating $c \sim F(c)$, and a probability density function $f(c)$, where c can be less than 0 so that some agents get a private benefit from donating.

Without Priority

Without a priority rule, organs are assigned randomly to anyone who needs one. There is no incentive for an agent to register as an organ donor. We define γ as the share of agents who become organ donors in equilibrium, which depends only on their costs of registering as an organ donor. Only agents with a cost $c \leq 0$ choose to register as donors. There is no additional incentive to register as a donor before priority is introduced, so $\gamma = F(0) = \int_{-\infty}^0 f(c)dc$. (Notice

that policies that lower the cost of donation, like the decreased cost condition in our experiment, will increase the proportion of agents who register to donate.)

A θ share of agents end up needing organs and a share β of agents suffer from brain death and are in a position to donate α organs each, but only if they have previously registered as an organ donor. This is true of the share of agents $\gamma = F(0)$. Consequently, the equilibrium probability of receiving a kidney conditional on needing one is $p = \min \left\{ \frac{\alpha\beta}{\theta} F(0), 1 \right\}$.

Notice that when $\theta \leq \alpha\beta F(0)$ then $p=1$, so all agents who need an organ receive one. To model an environment like the one in the U.S. today, where there is excess demand for organs, we assume in all that follows that $\theta > \alpha\beta F(0)$, so that not enough organs are provided in the equilibrium without priority.

With Priority

With the introduction of a priority rule there is now a benefit to registering as an organ donor. Now agents who have registered as donors get priority for any available organs, and those who are not registered donors only receive an organ if all registered donors who need an organ receive one. (If there are not enough organs to give all agents in a priority group an organ, then any available organs are assigned randomly among members of that priority group.) We again define γ as the share of agents who register as organ donors in equilibrium.

It should be noted that if $F(0) = 0$, so that no agents have a cost of contribution of 0 or less, then there is always an equilibrium in which no one registers as a donor, even under a priority rule. This equilibrium exists since an agent can never give an organ to himself, so there is no priority benefit to being the only registered organ donor. Notice that this does not result from assuming a continuum of agents; even with a finite number of agents, an agent can never donate an organ to himself. Consequently, we focus on the case $F(0) > 0$, so that at least some agents prefer to register as an organ donor even without priority and the no-registration equilibrium does not exist. This assumption mirrors the data in our experiment, in which agents registered as donors even in the control condition, and the data for organ donation in the U.S., where 37% of eligible adults are registered as organ donors in the absence of a priority rule.

We define the probability that a registered donor who needs an organ gets one as p_d . Under the priority rule, with $F(0) > 0$, p_d is

$$p_d = \min \left\{ \frac{\alpha\beta}{\theta}, 1 \right\}$$

where θ can now be interpreted as the share of registered donors who need organs (which is of course the same as the share of the general population).

We look for a cutoff equilibrium in the cost space, where c^* is defined as the cost at which agents are indifferent between registering as an organ donor and not registering. All agents with $c \leq c^*$ choose to register and all agents with $c > c^*$ choose not to register. Agents who do not register do not get priority and, if they need an organ, receive one with probability p_n , which is the share of remaining organs $(\alpha\beta - \theta)F(c^*)$ divided by the share of agents who are not registered donors but are in need of an organ $\theta(1 - F(c^*))$ or

$$p_n = \min \left\{ \frac{(\alpha\beta - \theta)F(c^*)}{\theta(1 - F(c^*))}, 1 \right\}$$

Note that $p_n = 0$ if $p_d < 1$, since all the donated organs are going to registered donors who ended up needing an organ. Equilibrium requires that

$$c^* = V\theta[p_d(F(c^*)) - p_n(F(c^*))]$$

so that the agent who has cost c^* is indifferent between not registering, which generates no cost and no benefit from registering, or registering, which generates a cost c^* and increases an agent's probability of receiving an organ (and thus increases the probability of a payout of V) by $\theta[p_d - p_n]$ where θ is the probability of needing an organ and $p_d - p_n$ is the increase in probability of receiving the organ with priority. Notice that the equilibrium depends on whether non-registered agents ever get an organ in equilibrium, this is equivalent to whether $\frac{\alpha\beta}{\theta} > 1$ or $\frac{\alpha\beta}{\theta} \leq 1$. We can think of $\frac{\alpha\beta}{\theta}$ as the "production-need ratio" of organs. When $\frac{\alpha\beta}{\theta} > 1$, registered donors who suffer brain death produce enough organs to supply organs to all the registered donors who need organs and some organs go to people who are not registered donors.

When $\frac{\alpha\beta}{\theta} \leq 1$ then $p_d = \frac{\alpha\beta}{\theta}$, so not all registered donors receive an organ when they need one (unless $\frac{\alpha\beta}{\theta} = 1$). In this case, $p_n = 0$. Thus equilibrium requires $c^* = V\theta \left[\frac{\alpha\beta}{\theta} - 0 \right] = \alpha\beta V$. So agents contribute when they have $c \leq \alpha\beta V$ and in equilibrium the share of agents who contribute is $F(\alpha\beta V)$. Notice that $F(\alpha\beta V) > F(0)$, so there are more donors under the priority rule. Here there is a positive incentive for registering as a donor in the form of a higher likelihood of receiving an organ if it is needed, which encourages donation.

When $\frac{\alpha\beta}{\theta} > 1$, all registered donors who need an organ receive one and there are organs available for some non-registered agents as well. In this case, $p_d = 1$ and $p_n = \frac{(\alpha\beta - \theta)F(c^*)}{\theta(1 - F(c^*))}$ (since we have assumed that $\theta > \alpha\beta F(0)$, which rules out $p_n = 1$). This means that in equilibrium

$$c^* = V\theta \left[1 - \frac{(\alpha\beta - \theta)F(c^*)}{\theta(1 - F(c^*))} \right]$$

which implies that

$$F(c^*) = \frac{\theta V - c^*}{\alpha\beta V - c^*}$$

This condition defines c^* and implies that $F(c^*) < 1$ (since $\alpha\beta > \theta$ in this case), so not all agents register as organ donors. Consequently, $p_d = 1$ and $p_n = 1 - \frac{c^*}{\theta V}$. The $\frac{\alpha\beta}{\theta} > 1$ case demonstrates the countervailing forces to register as a donor that are present in the model. First, there is an incentive for individuals to register as a donor in the form of a higher likelihood of receiving an organ if it is needed, which encourages donation. Second, there is a countervailing effect in that the extra donors generated by the priority rule are producing more organs for those who are not registered donors, so as more people register or more organs are provided, the chance of getting an organ when not registered increases.

Depending on the "production-need ratio" of organs, the share of agents who are registered as organ donors γ is given by

$$\begin{aligned} \text{if } \frac{\alpha\beta}{\theta} \leq 1 \text{ then } \gamma &= F(\alpha\beta V) \\ \text{if } \frac{\alpha\beta}{\theta} > 1 \text{ then } \gamma &= F(c^*) = \frac{\theta V - c^*}{\alpha\beta V - c^*} \end{aligned}$$

We can now examine the comparative statics of the model. First we examine the impact of a change in the production of deceased organs, $\alpha\beta$. Notice that if $\frac{\alpha\beta}{\theta} \leq 1$, then for a given θ , the equilibrium cost $c^* = \alpha\beta V$ and so is increasing in $\alpha\beta$. Once $\frac{\alpha\beta}{\theta} > 1$, however, c^* and thus $F(c^*)$ are decreasing in $\alpha\beta$. The comparative static is

$$\frac{\partial c^*}{\partial \alpha\beta} = \frac{-VF(c^*)}{f(c^*)(\alpha\beta V - c^*) + 1 - F(c^*)} < 0$$

This means that as more organs become available in expectation from each registered donor (say because transplant mechanisms become more efficient or brain death becomes more

common) then more agents register as donors until the registered organ donors produce enough organs to provide for some non-registered donors as well. After that point, as more organs are retrieved from each registered donor fewer agents find it optimal to contribute under the priority rule. Again, this arises because the benefit of priority decreases as more non-registered agents receive organs. Notice, however, that as $\alpha\beta$ increases, c^* and $F(c^*)$ fall because p_n rises, so more people receive organs even as fewer register as donors.

Now we investigate the impact of a change in the demand for organs, θ . When θ is low enough such that $\frac{\alpha\beta}{\theta} > 1$, c^* and thus $F(c^*)$, are increasing in θ . The comparative static is

$$\frac{\partial c^*}{\partial \theta} = \frac{V}{f(c^*)(\alpha\beta V - c^*) + 1 - F(c^*)} > 0$$

Meanwhile, if $\frac{\alpha\beta}{\theta} \leq 1$, then for a given $\alpha\beta$, the equilibrium cost $c^* = \alpha\beta V$, which does not depend on θ . Once θ is high enough (say because of a diabetes epidemic) the higher demand for organs does not increase the number of registered donors since there is an offsetting decreases in the chance of getting an organ, even with priority. This means that as the demand for organs rise (as the incidence of organ failure θ increases) more people register as donors until there are not enough organs to meet the needs of the registered donors, and then once $\frac{\alpha\beta}{\theta} > 1$ there is no change in the registration rate.

Notice also that regardless of the value of $\frac{\alpha\beta}{\theta}$, under a priority rule, the more valuable the benefit of receiving an organ in the event that one is needed, V , the more donors are generated by a priority rule. This fact is immediately clear when $\frac{\alpha\beta}{\theta} \leq 1$ and $c^* = \alpha\beta V$. When $\frac{\alpha\beta}{\theta} > 1$, the comparative static is

$$\frac{\partial c^*}{\partial V} = \frac{\theta - \alpha\beta F(c^*)}{f(c^*)(\alpha\beta V - c^*) + 1 - F(c^*)} > 0$$

since $\theta - \alpha\beta F(c^*) > 0$ unless everyone who needs an organ gets one.

While V does not impact the number of people who register as donors when there is no donor-priority, the more value there is to receiving an organ, the more people register as donors under a priority rule.

To summarize, the model illustrates the following additional differences between the donor-priority allocation rule and the current allocation rule without priority. Under the donor-priority scheme, the number of donor registrations responds to increased success in recovering

organs by increasing until enough organs are recovered that those without priority also have positive probability of receiving an organ, after which it decreases. The number of organ registrations also increases in response to an increase in the rate of organ failure, until so many organs are failing that all organs go to registered donors, after which there is no change in the donation rate as the organ failure rate continues to rise. Finally, as the value of transplantation compared to non-transplantation increases (e.g. through better surgical techniques that promise longer survival of the transplanted organ), so does the rate of donation under the donor-priority rule. In contrast, under the rule without priority, the registration rate does not vary in response to the recovery rate, the incidence of disease, or the increased benefit of transplantation.³¹

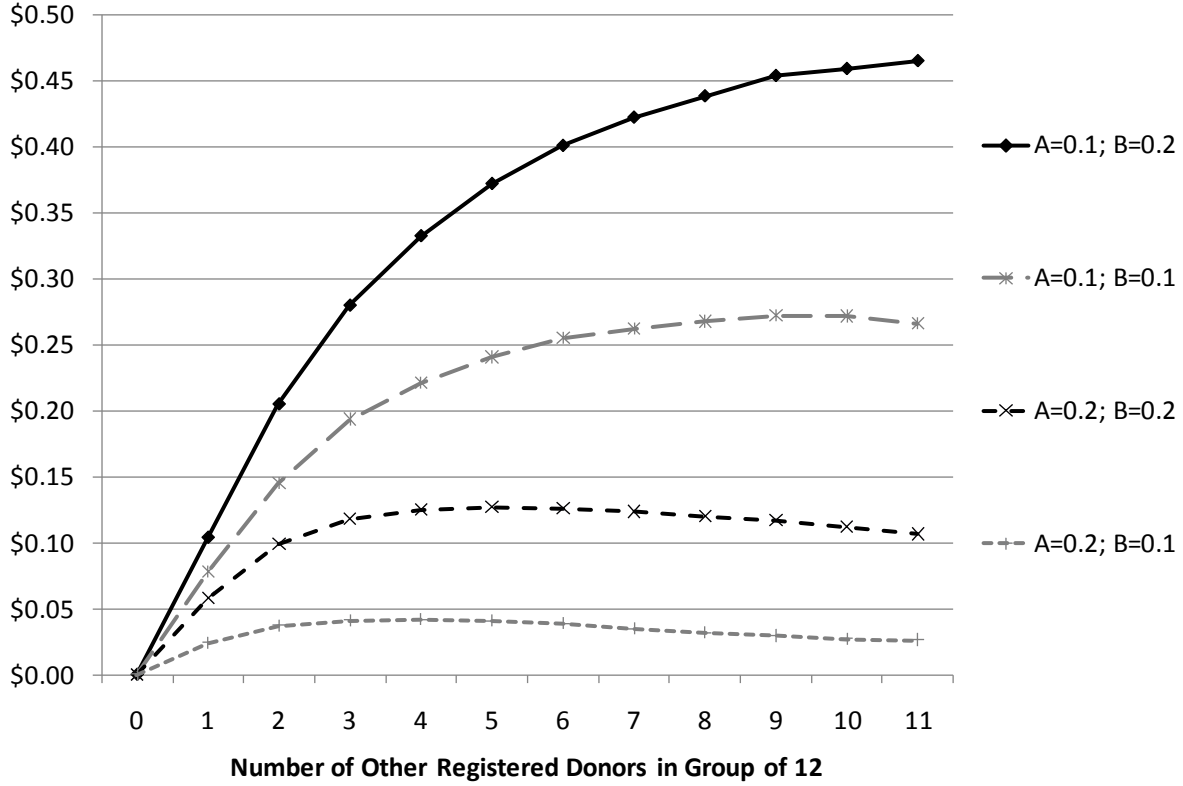
Experimental Parameters

Our experimental game has the same structure as the 2-period model outlined above. Subjects make registration decisions in period 1 and then payoffs are revealed. However, the payoff “period” has a more complicated structure and occurs over a number of periods instead of one. In our experiment, payoffs are generated by a stochastic process in which subjects suffer from B-unit failure with a 20% probability in each period and suffer brain death with a 10% probability in each period. Rather than collect and distribute all organs simultaneously, we introduce more complicated timing and allow subjects who have B-unit failure to survive for up to 5 periods without a B unit, during which time they may receive a B-unit and earn a stochastic payoff that is a function of the number of periods they survive after that.

Since the payoffs in the game are complicated, it is most useful to simulate the payoffs associated with priority. Figure 2 shows the expected benefit of receiving priority under the priority rule for different parameter values (based on 10 million simulations of each number of other donors for each set of parameters). The parameter values vary the probability of A-unit and B-unit failure for groups of 12 players who each have two B units available for donation when they suffer A-unit failure.

³¹ While not modeled here, it is possible that the “warm glow” some part of the population feels from the decision to register as a donor may respond to these changes in parameters under both a priority rule or a rule without priority.

Figure 2: Rebate Profiles



The top-most rebate profile is the benefit of having priority with the parameters actually used in the experiment. Notice that the benefit to having priority is increasing with the number of other donors and that even when all 11 other players are registered donors, there is still a significant benefit to having priority. One can interpret this feature of our payoffs as suggesting that there is a significant waiting list for organs (and so there is always a benefit to having priority).

Notice that while the payoff structure in our experiment guarantees that under a priority rule, a subject who is not a donor cannot get a B unit in a period when a subject who is a donor needs but does not receive one. However, the payoffs in the experiment are more complicated than in the model, which is a simplified version of both the experimental game and actual decisions to donate. Consequently, the rebate profiles in Figure 2 representing the benefit of priority collapse the benefits and costs and simply represent the benefit of priority, which is most similar to the value in the model of

$$V\theta[p_d(F(c^*)) - p_n(F(c^*))]$$

The functions in Figure 2 demonstrate the benefit to priority under different parameter values, which make the probability of brain death relatively higher (similar to increasing β) or the probability of organ failure lower (similar to decreasing θ) or both. These fit the comparative statics of the environment in the model when $\frac{\alpha\beta}{\theta} > 1$. Both of the comparative statics of increasing β and decreasing θ are associated with a decrease in the optimal cost associated with registering as an organ donor.³²

If the only costs the subjects face for registering as a donor in the experiment are the financial costs imposed in the experiment (and if subjects do not have altruistic or warm glow motive for donating) then in our experiment the only equilibrium of the game is for no one to register as a donor, even under the priority and rebate rules. Each group of 12 subjects had 6 subjects who had a donation cost of \$0.40 and 6 subjects who had a donation cost of \$0.80. Since the expected benefit of priority when 5 other subjects are contributing is only \$0.38, there is no equilibrium in which these 6 low-cost subjects all contribute. However, we see many subjects registering as a donor even without priority, suggesting that there may be altruism or warm glow associated with the decision to register as a donor. In the case of heterogeneous costs in which some agents contribute in the absence of a priority rule, we expect priority and the rebate conditions to generate more contribution than the control condition in equilibrium, which is what we observe in the experimental data.

Lifesharers

With the model providing intuition about behavior with and without priority rules, we can consider other proposals similar to the donor-priority rule discussed here. For example, the Lifesharers club has formed in the United States to provide priority-type incentives for registering as a donor and joining the Lifesharers club. Individuals who join Lifesharers and register as organ donors commit to directing their deceased organs to other members of Lifesharers who might need them.

³² In the three functions that lie below the rebate profile used in the experiment, the benefit to priority peaks in the interior, so while there is always a positive benefit of priority, it is not always increasing in the number of other donors. While the model assumed a distribution of costs of registering as an organ donor, if all subjects had a common cost of registering as an organ donor, there would be certain common costs at which a mixed strategy equilibrium would exist in which only some agents registered as organ donors and everyone was indifferent between not getting priority and incurring the cost of registering in order to get priority.

Notice that if the existence of the Lifesharers club were widely known and if registering as an organ donor automatically registered an individual in Lifesharers at no cost, the club would replicate the priority rule discussed here. However, the existence of the Lifesharers club is not widely known, and while there is no financial cost to joining the club, there may still be a cost of informing your next of kin that you are a member of the club (and that they will have to enforce your wishes to have your organs be granted first to other members of Lifesharers) or similar psychological costs to joining Lifesharers as with registering as an organ donor. As soon as there is an additional cost of joining Lifesharers, there is an equilibrium at which no one joins, since there is no benefit to being the only member of Lifesharers (and little benefit to being one of few members). Introducing a priority system nationally eliminates this non-participation equilibrium, since registering as a donor in a national donor-priority system provides priority access to the organs provided by all those people who chose to register as donors together with all the additional unregistered donors whose next of kin decide to donate their organs.

V. Discussion

The donor-priority rule significantly increased registration rates for organ donation in our experiment. When implemented at the start of the game, the priority rule was more effective at increasing donation rates than either the rebate or the discount. When implemented after subjects were familiar with the game, the increase in registration rates generated by the priority rule was also achieved by the discount that directly decreased the costs of donation and by the rebate that provided the same incentive for registration as the priority rule, and the same positive externalities to other donors, in expectation.

The rules for allocating deceased donor organs present a complex problem, because they determine not merely who receives the next available organ, but may also influence how many organs become available, by influencing the decisions of potential donors. As in other areas of market design involved with exploring incremental improvements to complicated existing institutions, it is necessary to think about how any proposed change will interact with existing rules and procedures (cf. Roth 2002, 2008). One reason this paper focuses on donor-priority rules is that we think that these might fit well with the existing legal and procedural institutions.

In this respect it is worth noting that there are other ways to change policy that could increase the number of registered organ donors. For example, one proposal that has received a good deal of attention would change the current “opt in” registration method used in the United States to an “opt out” system in which everyone is presumed to be a donor unless he or she actively indicates otherwise.³³ Another proposal, “mandated choice” would require everyone (e.g. who applies for a driver’s license) to specifically indicate whether they wished to be a donor or not. We want to briefly argue here that the priority rule that we consider may create a more direct link between registration as an organ donor and subsequent successful organ recovery and transplantation than policies that change the procedure by which individuals register as organ donors.

Attempts to increase organ donation rates by changing the default organ registration status (and adopting an “opt out” policy) would surely generate more organ donor *registrations*, since those who do not take any explicit action would automatically be registered as donors (see Johnson and Goldstein 2003, 2004, who find direct evidence that registration rates are higher with an “opt out” system).³⁴ However, such a policy may weaken the link between the registration decision and the legal clarity of the potential donors’ last wishes. Under current United States gift law, changing the default status is likely to have legal consequences that could be detrimental to organ retrieval.

Since the Uniform Anatomical Gift Act of 1968 (UAGA), an individual can make his or her own legally binding decision to be an organ donor after death, which does not require the consent of next of kin (Glazier 2009). However, a donor symbol on a driver’s license has not been considered sufficient evidence of the deceased’s intent to donate to proceed without permission from the next of kin. Aside from the fact that the driver’s license is often not available in a timely way, the law allowed that a registered donor could have changed his or her mind about donation subsequent to the issuance of the driver’s license (Glazier 2006).

³³ Switching to an “opt out” system might not be easy, as shown by the so-far-failed attempt to do so in Britain. In 2008, senior British politicians supported changing British organ donation registration from an “opt in” to an “opt out” system, but faced considerable opposition (<http://marketdesigner.blogspot.com/2008/11/british-organ-donation-opt-in-versus.html>). Bird and Harris (2010) report on the continued effort to change the system. Similarly, in a speech announcing a new organ donor registry in California, Governor Schwarzenegger said an opt out system had been suggested to him, but that an opt-out system was not plausible due to constitutional concerns (<http://gov.ca.gov/speech/16126/>).

³⁴ Manipulation of defaults in choice situations has been shown to be a powerful force in changing behavior in many settings (see Thaler and Sunstein 2008 and Benartzi and Thaler 2007).

In recent years, computer registries have allowed for fast checks of organ registration status. They also provide individuals with a way to easily change their organ donor status online, which allows the presence in the registry to be interpreted as intent to donate. The legal status of the anatomical gift has meant doctors can recover donated organs without receiving explicit permission the next of kin (see Glazier 2006). In contrast, a donor registration that does not reflect a positive decision to donate (as under an “opt out” policy) might not be taken as evidence of the deceased’s intent in the legally compelling way that registration is currently. Under an opt out policy, approval from next of kin might again become necessary for an organ to be transplanted.³⁵

A “mandated choice” system would also change the way in which individuals became registered donors (see Thaler and Sunstein 2008 and Thaler 2009). Under “mandated choice,” every individual who registered for a driver’s license (or potentially other state or federal documentation) would be required to indicate that he will be an organ donor or that he will not. While there is suggestive evidence that a “mandated choice” policy would (like “opt out”) generate more registration of organ donors (Johnson and Goldstein 2003, 2004), similar concerns arise about whether a change to mandated choice would lead to more donated organs and transplants. While the UAGA makes registering to be a donor legally binding under an “opt in” policy, *failing to register* as an organ donor is not a legally binding decision, whereas registering as a person who *declines* to donate would likely be legally binding on the next of kin.³⁶ Discussions with the staff at the New England Organ Bank suggests that they are able to recover organs from about half of all non-registered potential donors in New England by approaching next of kin. This means that more than half of the people who are not currently registered under “opt in” would need to choose “yes” in mandated choice to increase the recovery rate.³⁷

³⁵ In addition to finding high rates of willingness to register in a survey of potential organ donors, Johnson and Goldstein (2003, 2004) also suggest that more organs are recovered and transplanted in European countries that have “opt out” systems. Deffains and Ythier (2010) argue, on the other hand, that the success of organ recovery rates in Spain (which has the highest recovery rates in Europe) is not due to the “opt out” system but to the way in which the Spanish transplant system has professionalized the harvesting of organs, by specialists who do nothing else.

³⁶ Mandated choices could of course be framed so that a negative decision was merely recorded as a decision “not to register as a donor at this time,” but even this less binding formulation would likely inform next of kin’s beliefs about the deceased’s intentions and wishes.

³⁷ There is reason to believe, as discussed below, that individuals may be hesitant to register as organ donors due to fears over worse medical treatment of registered organ donors. In the presence of such fears, the optimal response might be for individuals *not to register* as a donor but direct next of kin to donate their organs after death. Recovery of the organs of these individuals might be made more difficult by “mandated choice.”

Consequently, it remains an empirical question whether a change to “mandated choice” would generate more organ transplants.

Even though registration under “opt out” and “mandated choice” systems may raise legal concerns about the intent of registrants under the UAGA, changing the procedure by which individuals register as donors may still be a fruitful avenue to pursue to increase organ donation and recovery.³⁸ Gift laws can also potentially be changed to address any legal concerns that might arise from new policies. We simply see these legal issues as additional hurdles to monitor and overcome in successfully implementing a change in registration policy. One attraction of the priority rule is that it seems to avoid these particular hurdles since it preserves the current donor registration process as is (and thus is consistent with current United States law regarding donor intent at time of death).

Although changing priority rules would involve a regulatory rather than a legislative process, a change such as we consider here would nevertheless involve substantial debate and principled opposition. Much of the opposition would likely have to do with thinking of priorities as reflecting justified claims. For example, we would not feel that a serial killer serving a life sentence who happens to be a registered donor would have a more justified claim to a scarce organ than an exemplary citizen who happened not to be registered as a donor.

While comparing the different mechanisms in our experiment, the priority rule, rebate, and discount all generate an incentive to donate that offsets the costs of donation. But the priority rule has two advantages over the rebate and discount both inside and outside of the laboratory. First, the simplicity and elegance of the priority rule (as suggested by its outperformance of the rebate and discount at the start of the game) suggests that its benefits are particularly clear and salient. As noted above, this may have a direct effect on getting subjects to donate or may lead subjects to believe others will be more likely to donate, which increases the benefit from priority. Second, and more importantly, the priority rule seems feasible to implement and can be implemented without any additional costs to the system. In contrast, decreasing the costs of registering to be an organ donor is difficult (it is difficult to both understand the costs and to decrease them) and decreasing net costs through monetary incentives is not currently allowed by the U.S. National Organ Transplant Act and by similar legislation in many countries.

³⁸ Some of the U.S. states have been pursuing these avenues independently. In New York, a discussion has recently begun about the potential to switch to an opt out system (see http://www.dailynews.com/news/ci_14970110) and Illinois has had a mandated choice system in place since 2006 (see Thaler 2009).

Decreasing the costs of registering to be a donor is a particular challenge in part because the costs are hard to identify. Since the physical removal of the organs only occurs after death and since the monetary costs are not borne by the donor's estate, it is unlikely that the costs are physical or monetary. Additionally, the costs appear to be more substantial than transaction costs, since registering to be an organ donor in most states only requires checking a box at the time of receiving a driver's license (and the registration rates remain low while the benefits to others are substantial). These facts suggest that the costs of registering to be an organ donor are most likely psychological costs.

The psychological costs may involve fear of improper medical treatment if registered as an organ donor. A national survey of 5,100 adults conducted in January 2010 on behalf of Donate Life America found that 52% of survey respondents believe doctors will try less hard to save them and 61% of survey respondents believed they might have their organs removed when they might still come back to life.³⁹ (Whether or not this is properly labeled as a "psychological" cost, it is a cost that seems difficult or impossible to decrease. For example, attempts to dispel the belief may only serve to strengthen it or introduce it into the minds of others). In addition, deciding to be an organ donor requires an individual to think about his own death, which may itself generate psychological costs. It remains unclear how these psychological costs can be effectively lowered. While future research should certainly investigate the costs to registering to be an organ donor and how policies aimed at decreasing these costs might work, allocation policy that implements a priority rule is likely to increase registration rates, even with the current costs in place.⁴⁰

In closing, care must always be taken in extrapolating experimental results to complex environments outside the lab, and caution is particularly called for when the lab setting abstracts away from important but intangible issues, as we do here. However the difficulty of performing comparable experiments or comparisons outside of the lab makes it sensible to look to simple experiments to generate hypotheses about organ donation policies. The results of our experiment lend support to the hypothesis that the priority rule used in Singapore and being introduced in

³⁹ Based on the Donate Life America *National Donor Designation Report Card 2010* (which can be found at http://www.donatelife.net/pdfs/DLA_Report_Card_2010_FINAL.pdf).

⁴⁰ Changes in allocation policy may have additional benefits beyond the incentives of higher priority in motivating individuals to register as donors. Contracts between agents have been shown to establish social norms that can lead to more prosocial behavior (Kessler and Leider 2010). By providing a benefit (in terms of higher priority for deceased donor organs) an allocation policy like the one in Singapore may act as an implicit contract, setting a social norm of behavior at registering to be a donor.

Israel is a potentially powerful policy tool. Results from this experiment suggest that it performs as well as or better than discounts and rebates that are of a similar magnitude to the benefits of priority, and that, along with other policies, it is a plausible mechanism to increase rates of registration.

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<http://marketdesigner.blogspot.com/search/label/chains>

<http://marketdesigner.blogspot.com/2008/11/british-organ-donation-opt-in-versus.html>

LEGISLATION

Section 301, National Organ Transplant Act (NOTA), 42 U.S.C. 274e 1984

Human Organ Transplant Act: <http://www.moh.gov.sg/mohcorp/legislations.aspx?id=1672>

PROPOSED LEGISLATION

http://assembly.state.ny.us/leg/?default_fld=&bn=A09865&Summary=Y&Actions=Y&Text=Y