The supply of organs for transplantation: decision making under ambiguous approval

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Abstract

During the last decade there have been major technical advances in the transplantation of human organs. However, the current system of procurement results in an inadequate supply of organs. Efforts to provide the benefits of technological innovations to patients have been hindered by supply limitations that are the consequences of a market ban and of a lack of incentives on the donor's side. This situation raises major economic questions. This thesis begins by reviewing the existing literature. Then the causes of, and possible solutions to, organ shortages are analyzed, drawing from economics and other social sciences. A model based on decision making under ambiguous approval, addresses reasons for people's refusal to donate organs.
PART I: INTRODUCTION

Invaluable goods, which do not have market valuations, and associated forbidden markets, are related to issues of law, ethical philosophy, and economics. Economists have noted the existence of attitudes regarding restrictions on the transferability, ownership, and use of invaluable goods, and implications about lack of willingness to allow trade in markets, only to dismiss such attitudes as constraints on market trade that cannot be expected to be effective.

Over time, attitudes and perceptions change. For example, in 1831, Jeremy Bentham asked: “of what use is a dead man to the living?” Bentham was arguing in favor of autopsies, which were illegal at the time. Autopsies have since become legal and have increased medical knowledge, but have also led to emergence of ethical dilemmas, such as whether to harvest organs for transplantation on brain death or when the heart stopped beating.

This thesis is in particular concerned with organs for transplant, for which free markets are in general not present because of societal attitudes and consequent prohibitions. The objectives are to offer explanations for the reluctance of people to donate organs and to examine means of increasing supply.

The issues associated with organ transplantation rely on economic analysis and are concerned with both justice and property rights. The need to rely on altruism as the only source of procurement, rather than a market based on supply and demand, makes the subject of organ procurement for transplantation a complex and sensitive subject.

Although relevant worldwide, the absence of a market for organs is of special interest in Israel, where the shortage of organs for donation is especially acute. While 500 people on average wait for kidney transplants every year, the number of donations remains in the range of 50 to 53 annually. This critical shortage of organs causes the death of many people every year.

Organ donation is the established treatment for the failure of vital organs such as the kidneys, pancreas, liver, heart or lung. Kidneys are by far the most common type of
organ transplant. For example, from among the several million people in the UK with chronic kidney disease, a small proportion, about 37,000, will develop end-stage renal failure (ESRF) for which regular dialysis or a transplant are the only treatments to prolong life. A successful kidney transplant is the most clinically-effective and also cost-effective treatment for many ESRF patients. At the end of 2004, 6,592 people were for example on the kidney transplant waiting list in the UK. During that year only 1,838 kidney transplants were preformed. Future demand for organ transplants is likely to continue to increase due to the rapid rise in some diseases, such a diabetes and hepatitis C, and also due to an aging population.

The increased demand and costs associated with health care have intensified the need to address complex equity and ethical issues while seeking the optimal distribution of technology-based health care services. This is particularly the case in organ transplantation, where the benefits of technology are widely known while the supply of organs is scarce. This shortage can lead to inequities in distribution, with the economically or socially disadvantaged denied opportunities for life-saving organs due to lack of political or social influence or ability to pay.

Some countries (US, UK) have an opt-in approach to organ donation. This requires potential donors and/or relatives to indicate their willingness for organs to be removed for transplantation. Individuals can indicate their wishes in a number of ways, by making their wishes known to relatives, by registering on the National Health System Organ Donor Register, or by carrying a donor card. In 2004 11.6 million people (19% of the UK population) were registered. Even so, the number of people awaiting a transplant greatly exceeds the number of organs available. The shortage of organ donors means that some 400 patients, mainly those waiting for life saving heart, liver or lung transplants, die each year before a suitable donor can be found. Some other European countries (Spain, Austria) have an opt-out approach where at death a person’s organs can be taken for transplantation unless he or she had registered the desire to opt out. With cadaver organ donation rates decreasing across much of the world, the success of the Spanish model is remarkable. In contrast, the situation elsewhere seems bleak. In the United Kingdom, as
in most of Europe, the number of solid-organ donors has decreased each year, from 896 in 1990 to 757 in 1998, a reduction of nearly 16%.

A black market often exits for organ supply. However, the existence of a black market undermines people’s faith in medicine and affects the system of voluntary organ donation.

This thesis examines the economic problems related to the issue of organ supply against the background of the excess demand caused by the shortages in the supply. The thesis continues in two parts. Part II provides background and literature reviews of medical aspects of organ transplantation and the economic writing on influences on organ donation. Included are psychological aspects dealing with the perception of transplantation among individuals. Statistical evidence is also presented on the shortage of organs. Part III sets out a decision-theoretic model that reflects the conflict about whether to donate or not that a family faces and considers the effects of advertising on that conflict. The thesis concludes with a summary and indications for continuing future research.

PART II: BACKGROUND

2.1 Medical aspects of transplantation

In the last half-century, organ transplantation has developed from gothic science-fiction procedure to daily medical reality. Today, over ten thousand people each year all over the world receive such transplants as lungs, livers, kidneys, bone, and skin, in procedures that dramatically improve the length and quality of the recipients' lives. Success has led this once highly controversial practice to be firmly entrenched in the modern medical norm and to be enthusiastically accepted by much of the world population.
2.1.1 What is a transplant?

An organ transplant is the replacement of one or more of one's organs with one that has been donated by someone else. The donated organ comes from someone who has died. Most of the transplanted organs are kidneys. Therefore I will use the example of kidneys. The need for kidney transplantation emerges as a result of End Stage Renal Disease (ESRD), also known as chronic kidney disorder, which is a fatal disease unless treated with dialysis or kidney transplantation. A transplant is the preferred treatment because it enables the patient to resume a normal life.

2.1.2 Alternative treatments

Dialysis treatments are given mostly 3 times a week, for 4 hours at a time, in order to replace the function of failed kidneys by cleaning the toxins and extra fluid from the blood. The procedure of dialysis involves going to a dialysis center and having two large needles inserted into the arm, so that blood can flow out to the dialysis machine to be cleaned and then back into the body. The patient has to go on a strict diet in order to limit the intake of potassium, sodium, phosphorus and fluids, substances that can build up in the blood and become toxic if the kidneys are not working properly. The combination of visiting a hospital three days a week, the treatment, and the strict diet lowers the patient’s strength. The patient cannot work in a full time job and sometimes cannot work at all. For example, the current cost of treating these people has been estimated at 1-2% of the total UK National Health System budget, although they comprise only 0.05% of the adult population.

2.1.3 Unique aspects of kidney transplantation

Most often transplantations are feasible only from cadavers, because removing the organ causes immediate death. The case of kidneys is different because one can live with only one kidney and the operation of removing a kidney is quite safe. Transplantations from live donors generally have a higher chance of success than those from cadavers. The way such transplants are typically arranged is that a patient identifies a healthy willing
donor (a spouse, for example) and, if the transplant is feasible on medical grounds, it is carried out. If the transplant from the willing donor is not feasible, the patient typically enters (or remains on) the queue for a cadaver kidney, while the donor returns home.

The first successful kidney transplantation was in Boston in 1954; the donor and the recipient were identical twin women. The surgeon, who preformed the operation Dr. Joseph Murray, received the Nobel Prize for his accomplishments. Two genetic characteristics play key roles in the possibility and success of a transplant. The first is blood type. There are four blood types A, B, AB and O, representing which of two proteins, A and/or B are present. In the absence of other complications, kidneys can be successfully transplanted if they do not contain blood proteins that are foreign to the patient. The second is the tissue type: this comprises a combination of six proteins, two of type A, two of type B, and two of type DR.

2.2 Economic literature

2.2.1 The general issue of prohibition of markets

Hillman (2003, chapter 5.3) discusses the issue of prohibitions of markets, stating that there are legal markets that exist because of convention. For example, “Markets in tobacco products would not be legally allowed if tobacco were a newly introduced product that was required to satisfy contemporary health safety standards”. The market exists and is legal, although people harm themselves by using tobacco, because of convention and the political infeasibility of banning it. In conventional markets, most trade is made possible by the use of money. Conversely, some markets, and the people who participate in them, may wish not to use money for a number of reasons, one of which is denial of the venality of the transaction. For example, sexual favors are often traded for “gifts” rather than money in order to avoid the stigma of prostitution.
2.2.2 Turning organs into commodities

Why not put organs up for sale? If treating organs as commodities means putting a value on them and allowing the market to govern their use and production, exchange, and distribution, we may encounter a serious problem with an unregulated market in organs. In Kanbur's (2001) view, the problem with turning human organs into commodities has three aspects:

(1) Extremity of outcomes: the outcomes could be extremely negative, because the donation of organs is virtually irreversible. Furthermore, people can also be kidnapped for their body parts.

(2) Agency problems: As Kanbur noted, “it is unreasonable to assume that an individual can truly conceptualize life without that body part and even the individual himself or herself may not be the best judge of future well-being”. Time inconsistency arises when a poor individual sells an organ, and does not consider the future consequences of his or her act.

(3) Inequality in market relations: those who wish to sell their organs are mostly poor while the buyers are rich.

While Kanbur (2001) discusses the problems involved in organ donation by living people, studies by Abadie and Gay (2004), Ahlert (2004) and Byrne and Thompson (2000) analyze cadaveric organ donation. Byrne and Thompson (2000) deal with the financial incentives for potential donors that sign a donation card. According to them, some part of the population that signs in order to receive the reward will prefer not to have their organs harvested after receiving the financial payment. As a consequence, their family members will refuse to permit harvesting the organs. In that case, financial payments distort the signal because the family does not know if their beloved really wants to donate or is attracted by the financial incentive.
2.2.3 Titmuss

Titmuss (1971), in his book "The Gift Relationship" compares blood donations in Britain (voluntary) and in the US (some donated, some bought and sold). His book remains relevant though almost 30 years have passed since its publication. Titmuss addressed two main questions: (1) "What are the consequences, national and international, of treating human blood as a commercial commodity? (2) If blood is morally sanctioned as something to be bought and sold, what ultimately is the justification for not promoting individualistic private markets in other component areas of medical care?" Titmuss (1971, p.157), through empirical research, identified three major findings.

(1) A private market in blood opens recipients to greater risk of disease, chronic disability, and death.

(2) A private market in blood is more dangerous to the health of donors.

(3) A private market produces greater shortages in blood in the long run.

Although it is clear that the blood supply is safer now than in Titmuss's time, this safety has come at a high cost, both medically and economically. Blood supply does not seem to have appreciably increased.

Titmuss (pp.220-21) notes another problem is relevant to our discussion about human organs:

[in the] expanding fields of human experimentation-as with plasmapheresis programs-virtually all the strangers who give, by inducement, for money, or in captive situations, are poor people; the indigent, the deprived, the educationally handicapped, the socially inadequate (in and out of prisons and other institutions), and all those described by an American sociologist as "inept" in advancing the hypothesis that modern economic systems "utilize the inept more efficiently".

Titmuss compared the vast differences in both the quality and quantity of the blood supply between countries with a voluntary donor system and those with a market system.
He observed that the problems in countries with the market system could carry over into other areas, particularly the issue of organ donation.

### 2.3 The supply of organs

Procurement of organs is a severe problem, especially because not everyone agrees on the definition of when "death" occurs. Does it happen when the heart and lungs stop, when the entire brain ceases to have activity, or when the "higher functions" cease? This is an important issue, because no one wants to take organs from someone still "alive," but waiting for "whole brain death" can leave many organs unusable. I shall not further discuss the issue of the definition of the moment of death.

There are two main sources of kidneys for transplantation: cadaveric kidney donations, and living kidney donations by related and unrelated donors. Kidneys are for sale in some countries where this is not illegal (India and some far eastern nations). In these cases supply is not in black markets but is legal. Poor people donate (or sell) their organs for compensation. This practice is not legal in any Western country. There are problems with the legal supply in foreign markets because the purveyors can fabricate lab reports and donor's health history so neither quality nor compatibility is assured.

In Israel, as in the western world, a market for organs is forbidden, and organs, therefore, come from people who have died, if the family of the deceased agrees. However, in the majority of cases family does not comply in permitting organ use. Patients who match the blood type of the deceased thus continue to wait for an organ, and may even die during the extended wait.

Although societal norms are in general mostly efficient, they could not successfully replace the role of the market. Indeed, organ donation could be a win-win situation: one side enjoys the contribution while the other does not lose anything, which is Pareto efficient. However, in the present case, since an organ market does not exist, norms are only second best, and are not replaced because of inertia or fear of the harm that could be incurred. Thus, we are left with the norm that people donate organs in order to save the life of others, but this norm is inefficient. In reality, most people do not
donate (giving countless reasons why they do not or cannot donate), while ill people waiting for organs die.

Thus, charity or free voluntary supply can in principle replace a market, but we see that it has not. A solution is a market where a price is set for organs. However in this thesis my purpose is to investigate ways to improve the functioning of the social norm underlying voluntary free supply.

2.4 The literature on improving supply

In this section I outline suggestions in the literature for improving the current situation exist. I subsequently propose my model.

2.4.1 Kidney exchange

Roth, Sonmaz, and Unver (2004) investigated how a system of exchange might be organized in order to achieve efficiency through offering consistent incentives to patients, donors, and doctors. They also investigated welfare implications. The components of kidney exchange were:

*Paired exchange* involving two patient-donor couples, for each of whom a transplant from donor to intended recipient is infeasible but such that the patient in each couple could feasibly receive a transplant from the donor in the other couple. This pair of couples can then exchange donated kidneys.

*Indirect exchange* involving exchange between one immunologically feasible patient-donor couple and a cadaver queue, where the patient in the couple becomes the highest priority person on the cadaver queue, in return for the donation of his or her donor’s kidney to someone in the queue. This improves the welfare of the patient in the couple compared to having a long wait for a suitable kidney, and it clearly benefits the recipient of the live kidney and others in the queue who benefit from the increase in kidney supply due to an additional living donor.
2.4.2 Private clubs

Ahlert (2004) discussed the issue of "private vs. public" healthcare. According to Ahlert, there is a collective good aspect to private resource pooling. He presents a moral case in favor of the private organization of cadaver organ donation and allocation in private clubs, claiming that private clubs provide an incentive for members to donate by assurance of priority should they need an organ for themselves. Ahlert proposes that the idea of private clubs for organs should be encouraged. The first argument in favor of clubs is that the diverging religious convictions relating to cadaver donation do not fit under any single public rule. Thus separating a society into different groups minimizes disagreement about the cause of the death. The second argument is intended to address the ethical problem of allocation of organs. In the absence of clubs, with two equally needy and equally suitable potential recipients, the one who explicitly rejected organ donation in case of his own death may be preferred over the one who had been a voluntary cadaver donor almost all her or his life time. The third argument is that considerations like income or wealth do not enter into the decision whether to exclude a person from the club.

2.4.3 Presumed consent

Abadie and Gay (2004) discuss the differences in policies regarding donor consent. Cadaveric organ extraction often requires the explicit consent of the donor before death, which usually appears on a donor registration card. In most European countries, however, a deceased individual is classified as a potential donor in absence of explicit opposition to donation before death. However, in practice, regardless of the type of legislation and of whether a deceased individual is registered as a donor (or as a non-donor), in most countries families have the last word on whether organs will be donated. Countries that have passed presumed consent legislation do however have higher organ donation rates.

2.4.4 Attitudes to donations
In this section, after presenting statistics about the percentage of donors and other explanations for the low figures, I focus on issues involved in organ donation stemming from psychology and economics, and offer a model that looks at the unique relationship between signature on donation card and actual donation, and the effect of advertising on them.

In the case of Sweden, the number of donors has been declining over the past decades, from about 16 per million in 1988 to less than 12 in 1996. In Israel, only 3.75% of the population has signed a donation card. In a gallop survey taken in 1993 in the US, 6,127 people were asked about their attitude towards organ donation. The first main section dealt with general support/opposition to organ donation and it was found that while 85% of the participants support organ donation, 69% were likely want to have their organs donated after their death. In the section perspectives on donation and transplantation, where the participants responded to the statement "organ donation allows something positive to come out of a person's death", 90% of the participants strongly agreed while only 7%, strongly disagreed. The participants believed that 79% of the patients who needed a transplant would accept one. The potential barriers to donation are not so strong (at least at the conscious level). Only 21% thought that it is possible for a brain dead person to recover from his/her injuries. 13% thought that it is impossible to have a regular funeral service following organ donation, and 17% agreed that it is important for a person's body to have all of its parts when it is buried. An interesting statement was 'organs for transplant can be bought and sold in the black market in the US'. 34 percent of participants agreed that the existence of a black market is one of the major barriers to donation. 80% believed that a person should carry a signed donor card giving permission to donate. These results suggest a significant level of misinformation about the necessity of permission currently required for organ donation. If we combine the results with the fact that 34% believe that a black market actually exists in the US, we see that the existence of a black market is a major barrier towards donation.
2.4.5 Personal fears

Why do people not contribute organs? In the Gallup survey, participants were asked: "is there a particular reason you are not likely to want to have your organs donated upon your death? What might that reason be?" This question was directed to the respondents who reported they are not likely to want to have their organs donated. Nearly half of the respondents unwilling to donate their organs were unable to give a concrete reason for their current stand. One can speculate that fear of confronting the reality of death is involved. In the Encyclopedia of Philosophy, Soberly writes: 'death terrorizes us, not because we fear it is painful, but because we are unwilling to lose consciousness permanently'. Epicurus wrote that 'death is nothing to us...it does not concern either the living or the dead, since for the former it is not, and the latter are no more'. Though Epicurus was making an interesting point, there is psychological evidence that most people do fear death.

People in general do not want to hear anything about what is going to happen when they die. Bassett (2002) found that, although most people report little concern about death, self-reported measures may underestimate the extent to which people actually fear death because this fear may exist unconsciously.

In three studies, implicit death anxiety was assessed using the Implicit Association Test, the emotional Stroop task, and the affective Simon paradigm. Since these measures are based on reaction times rather than on self-reporting, one might expect them to be less biased by defensive distortions or impression management and to provide a clearer picture than more traditional questionnaires relating to concern with death. When the relation of IAT and Stroop measures of implicit death anxiety to explicit death anxiety was examined, a discrepancy was indicted between self-reported death attitudes and implicit death attitudes as measured by reaction time tasks.

2.4.6 Terror management theory (TMT)

Based on the work of Ernest Becker (1973), TMT posits that worldwide or cultural belief systems serve to buffer anxiety that is rooted in the uniquely human
awareness of mortality. Worldviews related to religious and political ideologies, and ethics, transform a chaotic and unpredictable world of inevitable death into a meaningful world of order and predictability. Worldviews elevate humans above mere mortal creatures that are ultimately destined to die and thus help people manage the terror that would otherwise manifest from the realization that all of life's roads are dead ends.

Numerous studies have shown that people react to thoughts about their own death (mortality salience) by support for their worldview. For example, a study by Grinberg (1990) shows that Christian participants who were asked to write about their own death, compared to those in the control group, showed increased positive reactions to other Christians, and decreased positive reactions to Jews.

PART III: A MODEL OF DECISION MAKING UNDER AMBIGUOUS APPROVAL

3.1 Summary of the model

Chronic shortage of human organs for transplantations is one of the most critical heath policy issues all worldwide. In recent years the constant shortage of organs for transplantation has led to the establishment of non-profit organizations in order to close the gap between the supply and demand of human organs. These organizations use advertising and other methods of persuasion. However, the number of actual donations does not increase and in some countries it has even decreased.

An assumption seems to be that the efforts at persuasion will increase the number of signatures on donation cards. In the model that follows, I show how such efforts can negatively impact on the decisions of family members. I show how efforts of persuasion to donate the organs of a deceased person distort the signal about the true wishes of their relatives with respect to organ donation, and result in circumstances of ambiguous approval. I demonstrate how a pooling equilibrium such that all people sign a donation
card due to advertising will cause family members to bypass the signal of their relatives having signed the donation card.

3.2 Introduction

As pointed out in Part II, a limited supply of organs continues to hinder organ transplantation. A major obstacle to organ donation is the fact that the final decision is made by family members and not by the donors themselves and that significant potential donations are lost through inability to obtain consent for donation from family members. At the same time, more than one million people around the world have benefited from organ donations, which remain the primary treatment for many diseases.

From a legal perspective, organ donations seem simple. Signing a card or checking off the donor box on the back of a driver's license indicates the intention to donate. A campaign to increase such commitments to donate might seem sufficient to solve the problem of deficient organ supply. However, the potential donor, when faced with the decision whether or not to sign a card, can face a sudden surge of subliminal thoughts about his or her own death.

People sometimes sign to obtain relief from thoughts about death. Often these thoughts are immediately drawn back into the subconscious, but with slight pressure the thoughts cannot continue to be suppressed.

At the final stage of organ donation, the donor's document serves as a legal statement of an individual's will. At this stage, the impediment arises of the grief of the family members who may not themselves be comfortable with organ donation, especially from the body of their own relative. This places an obstacle in the path of donation when family consent is necessary for donation. If family members believe that a donor card may have been signed under pressure, they will not accept the intention to donate indicated by the signed card at face value.

Another option in becoming an organ donor is talking with the family about the decision instead of signing a card. This step, however, raises organ donation to an entirely different level of effort and commitment. Whereas signing a donor card requires partial
awareness of the presence of death, having a conversation with family members about death often involves painful and awkward emotions.

When the family members do not support organ donation and a substantive discussion needs to take place, the passive approach of signing a donor card provides an alternative to the thought of dredging up tears, arguments, and questions of mortality. The absence of conversation can however place doubt in the minds of family members about the true intentions of the potential donor. Thus, a signed donor's card does not confirm the wishes of the potential donor. It can only be used as a signal. Furthermore, this is a distorted signal if influenced by advertising. When individuals choose their actions not only on the basis of their utility but also on the basis of the utility function of their relatives, there is a bias. This bias is particularly important in cases where individuals place high weight in their decisions on preferences of their relatives. This makes the significance of a credible signal a major consideration in the supply of organs. I now build on the decision model of Ben Yashar and Nitzan (2001) to demonstrate how an advertising campaign can be expected to affect supply of donated organs.

1 According to Susan Ristine with TDH's Anatomical Gift Educational Program, the most important part of deciding to become an organ donor is to share that decision with a family member. Even if you have signed a donor card or indicated your wishes to be an organ donor on your driver license, your family will be consulted before the donation process can take place. Studies show that while most people support organ donation, less than half actually choose to donate. Guadagnoli, Christiansen, DeJong, McNamara, Beasley, Christiansen, and Evanisko (1999), investigated the public's willingness to discuss their preference for organ donation with family members and to identify factors associated with willingness to discuss donation. Their sample consisted of 4365 individuals. They found that people that signed a card are more likely to talk with their family about their preferences. However more then half of those who wish to donate have not made their wishes known.
3.3 The model

There are two groups in the population. Group 1 consists of people who want to donate, and group 2 consists of those who do not want to donate. The size of each group is normalized to 1. The proportion of people in group 1 who sign a donation card is denoted by \( \varepsilon \). In group 2 no one signs a donation card. Due to the critical shortage of organs for transplantation an advertising campaign seeks to persuade people in both groups to agree to sign declarations of organ donation. Some of the people who did not want to donate their organs consequently sign the donation card and some of those who wanted to donate and did not previously also sign. The intensity of the advertising campaign is measured by the level of success, namely the proportion \( \delta \) of "non-signers" who sign a donation card following the campaign. I assume that the campaign influences both groups with the same level of intensity \( \delta \).

Following the campaign, the number of cards that have been signed is \( \varepsilon + \delta (1 - \varepsilon) + \delta \), out of which \( \varepsilon + (1 - \varepsilon) \delta \) actually want to donate and \( \delta \) do not want to donate. The number of people who have not signed is \( (1 - \delta)(1 - \varepsilon) + (1 - \delta) \), out of which \( (1 - \delta)(1 - \varepsilon) \) actually want to donate and \( (1 - \delta) \) in fact do not want to donate.

Consequently, given a signed donation card of a deceased person, the a priori probability that the deceased wished to donate is

\[
\alpha = \frac{\varepsilon + (1 - \varepsilon) \delta}{\varepsilon + (1 - \varepsilon) \delta + \delta}
\]  

(1)

Given no signed donation card of a deceased person, the a priori probability that deceased wished to donate is
\[ \gamma = \frac{(1 - \delta)(1 - \varepsilon)}{(1 - \delta)(1 - \varepsilon) + (1 - \delta)} \]  

(2)

The family of the deceased person wishes to act in accord with the wish of the deceased. I assume that issues related to death are not discussed; however, family members receive a signal \( \tilde{u} \) about the intentions of the individual, based on character and his previous actions, where \( \tilde{u} = f(z) \), with \( z \) is a vector of characteristics and actions taken in the past by the deceased.

The effect of the campaign on the a priori probabilities in the case of signed cards is:

\[ \frac{\partial \alpha}{\partial \delta} = \frac{\varepsilon \delta - \varepsilon}{(\varepsilon + (1 - \varepsilon)\delta + \delta)^2} < 0 \]

Rewriting (2) we obtain that \( \gamma \), the a priori probability that an agent who did not sign really wanted to donate, is

\[ \gamma = \frac{1 - \varepsilon}{\varepsilon} \]  

(3)

This a priori probability is not affected by the campaign since

\[ \frac{\partial \gamma}{\partial \delta} = 0 \]

In the case where the agent signed a card, \( \alpha \) denotes the a priori probability that he or she really wanted to donate his organs. Without the advertising, the signal is credible and equal to 1, but due to the "noise" created by the campaign, \( \alpha < 1 \). In the extreme case where \( \delta = 1 \), we have \( \alpha = \frac{1}{2} \). Then everyone signs but the families can not discriminate
between those who really wanted to donate and those who do not but signed under the influence of the campaign.

The family can only estimate the deceased's utility from donation by the signal $\tilde{u}$, which is drawn from a known distribution function given by the density $f_1$ for people who wanted to donate, and by $f_2$ for people who did not want to donate. The signal $\tilde{u}$ is derived from the aggregation of a vector of characteristics of the deceased related to the issue of donating and helping others.

The deceased may want to donate his organs ($s=1$) or may not ($s=-1$), and the family can decide whether to donate ($a=1$) or refuse to donate ($a=-1$). The decision matrix for each individual is therefore:

<table>
<thead>
<tr>
<th>Decision of the family</th>
<th>Wish of the deceased</th>
</tr>
</thead>
<tbody>
<tr>
<td>Donate</td>
<td>Do not donate</td>
</tr>
<tr>
<td>Agree</td>
<td>(1, 1)</td>
</tr>
<tr>
<td>Refuse</td>
<td>(-1, 1)</td>
</tr>
</tbody>
</table>

$R$ reflects the decision making quality and used as the information threshold, which determines if the family will agree to donate the organs, in the case where a signed donation card exists. If $U>R$ the decision is to donate, and will not otherwise to refuse.

The probabilities of a correct decision when people sign a donation card are:

$$p^{\theta_1} = \Pr\{a = 1 | s = 1\} = \int_{\tilde{u}} f_1 d(x)$$

and
\[
p^{R_2} = \Pr\{a = -1|s = -1\} = \int_{-\infty}^{R^*} f_2(x) \, dx
\]

\((1 - p_1)\) and \((1 - p_2)\) can be defined as type I and type II errors. Type I error means that the family will donate organs of someone who signed a card but did not really want to donate. Type II error means that family members refuse to donate organs of someone who did not sign a donation card and really wanted to donate. \(Q\) is the information threshold for a decision to donate when a signed donation card does not exist.

The probabilities of correct decisions when people do not sign a donation card are:

\[
p^{O_1} = \Pr\{a = 1|s = 1\} = \int_{Q^*}^{\infty} f_1(x) \, dx
\]

and

\[
p^{O_2} = \Pr\{a = -1|s = -1\} = \int_{-\infty}^{Q^*} f_2(x) \, dx
\]

We assume that \(\frac{\partial p_1}{\partial R} < 0\) and \(\frac{\partial p_2}{\partial R} > 0\), \(\frac{\partial p_1}{\partial Q} < 0\) and \(\frac{\partial p_2}{\partial Q} > 0\).

Note that the existence/ non-existence of a signed donation card is a signal for the decision-making family. When a greater percentage of people sign a donation card due of the campaign, the signal holds less information.

Furthermore, the more people who sign because of the campaign, the less information the signal holds, implying that \(\alpha\) is a decreasing function of \(\delta\).
The utilities of the four possible outcomes are denoted by $B(1, 1)$, $B(-1,-1)$, $B(1,-1)$ and $B(-1, 1)$. For example $B(1, 1)$ denotes the utility from choosing to donate the organs when the deceased truly wanted them to be donated. The family determines the threshold criterion $R$ with the aim of maximizing its expected utility.

The family members determine the donation threshold $R$ so as to maximize its expected utility. Given $f$, the problems that the family faces are:

Max $U_R$

$$U_R = \frac{\varepsilon + (1 - \varepsilon)\delta}{\varepsilon + (1 - \varepsilon)\delta + \delta} B(1/1) p_1^R + \frac{\varepsilon + (1 - \varepsilon)\delta}{\varepsilon + (1 - \varepsilon)\delta + \delta} B(-1/1)(1 - p_1^R) + (1 - \frac{\varepsilon + (1 - \varepsilon)\delta}{\varepsilon + (1 - \varepsilon)\delta + \delta})$$

$$B(-1/-1)p_2^R + (1 - \frac{\varepsilon + (1 - \varepsilon)\delta}{\varepsilon + (1 - \varepsilon)\delta + \delta})B(1/-1)(1 - p_2^R)$$

Max $U_Q$

$$U_Q = \frac{(1 - \varepsilon)(1 - \delta)}{(1 - \varepsilon)(1 - \delta) + (1 - \delta)} B(1/1)p_1^Q + \frac{(1 - \varepsilon)(1 - \delta)}{(1 - \varepsilon)(1 - \delta) + (1 - \delta)} B(-1/1)(1 - p_1^Q) +$$

$$(1 - \frac{(1 - \varepsilon)(1 - \delta)}{(1 - \varepsilon)(1 - \delta) + (1 - \delta)}) B(-1/-1)p_2^Q + (1 - \frac{(1 - \varepsilon)(1 - \delta)}{(1 - \varepsilon)(1 - \delta) + (1 - \delta)})B(1/-1)(1 - p_2^Q)$$

In order to find the optimal decision making criterion $R^*$, we will derive $U_R$ by $R$. First order conditions require that the following holds:

$$\frac{\varepsilon + (1 - \varepsilon)\delta}{\varepsilon + (1 - \varepsilon)\delta + \delta} B(1/1) \frac{\partial p_1^R}{\partial R} + \frac{\varepsilon + (1 - \varepsilon)\delta}{\varepsilon + (1 - \varepsilon)\delta + \delta} B(-1/1) \frac{\partial p_1^R}{\partial R} + (1 - \frac{\varepsilon + (1 - \varepsilon)\delta}{\varepsilon + (1 - \varepsilon)\delta + \delta})$$

$$B(-1/-1) \frac{\partial p_2^R}{\partial R} - (1 - \frac{\varepsilon + (1 - \varepsilon)\delta}{\varepsilon + (1 - \varepsilon)\delta + \delta})B(1/-1) \frac{\partial p_2^R}{\partial R} = 0$$

(4)
B(1) and B(-1) will denote, respectively the positive net utility when the correct decision is 1 (utility when the family approves donation when the deceased really wanted to do so minus the utility when the family approves donation and the deceased did not want to), or -1 (utility when the family does not approve donation and the deceased did not want to donate minus the utility when the family does not approve donation and the deceased really wanted to donate).

Rewriting (4) we see that the family's optimal decision making criterion $R^*$ is determined by following necessary condition:

\[
\frac{\partial p_{R_1}}{\partial R} = -\frac{(1 - \varepsilon + (1 - \varepsilon)\delta - \varepsilon + (1 - \varepsilon)\delta + \delta)B(-1)}{\varepsilon + (1 - \varepsilon)\delta + \delta} \quad \frac{\partial p_{R_2}}{\partial R}
\]

Now, we need to find the optimal $Q^* = f(\alpha(\delta))$.

In order to find the optimal decision-making criterion we will derive $U_Q$ by $Q$, which gives the first order condition:

\[
\frac{(1 - \varepsilon)(1 - \delta)}{(1 - \varepsilon)(1 - \delta) + (1 - \delta)} B(1/1) \frac{\partial p_{Q_1}}{\partial Q} - B(-1/1) \frac{\partial p_{Q_1}}{\partial Q} + (1 - \varepsilon)(1 - \delta) \frac{\partial p_{Q_2}}{\partial Q}
\]

The organization's optimal decision making criterion $Q^*$ is determined by the necessary condition:
\[
\frac{\partial p_1^0}{\partial Q} = \frac{(1 - (\varepsilon)(1 - \delta))}{(1 - \varepsilon)(1 - \delta) + (1 - \delta)} B(-1) \frac{\partial p_2^0}{\partial Q} \\
(1 - \varepsilon)(1 - \delta) + (1 - \delta) B(1)
\]

(7)

I define the implicit function \( F^R \) as follows:

\[
F^R = \frac{\partial p^R_1}{\partial R} + \frac{(1 - \varepsilon)(1 - \delta + \varepsilon)}{\varepsilon + (1 - \varepsilon)\delta + \delta} B(-1) \frac{\partial p^R_2}{\partial R} = 0
\]

Using the implicit function theorem I find that:

\[
\frac{\partial R^*}{\partial \delta} = -\frac{\frac{\partial F}{\partial \delta}}{\frac{\partial F}{\partial R^*}} = -\frac{\frac{\varepsilon}{(\varepsilon + (1 - \varepsilon)\delta + \delta)^2} \frac{\partial p^R_2}{\partial R}}{\frac{\partial^2 p^R_1}{(\partial R^*)^2} + \frac{(1 - \varepsilon)(1 - \delta + \varepsilon)}{\varepsilon + (1 - \varepsilon)\delta + \delta} B(-1) \frac{\partial p^R_2}{\partial R}} > 0
\]

(8)

The denominator must be negative because of second order conditions for maximization and the nominator is positive \((0 < \varepsilon < 1)\)

**Result 1:** In the case of a signed card, an increase in campaign intensity increases the optimal decision threshold, \( R^* \).

Result 1 implies that, when the campaign intensity increases, ambiguity increases, and families require a higher level of donor’s utility in order to agree to the donation. This is because a signed donation card looses its credibility in determining the a priori probability of true donation.

I now define the implicit function \( F^Q \) as follows:
\[
F_Q = \frac{\partial p_1^0}{\partial Q} - \frac{(1 - \varepsilon)(1 - \delta)}{(1 - \varepsilon)(1 - \delta) + (1 - \delta)} B(-1) \frac{\partial p_2^0}{\partial Q} \frac{(1 - \varepsilon)(1 - \delta) + (1 - \delta)}{B(1)}
\] (9)

Using \(F_Q\) and the implicit function theorem, we obtain:

\[
\frac{\partial Q^*}{\partial \delta} = -\frac{\partial F}{\partial \delta} = \frac{0}{(1 - \varepsilon)(1 - \delta)^2} = 0
\]

\[
\frac{\partial^2 p_1^0}{\partial Q^*} \left( \frac{1 - \varepsilon(1 - \delta)}{(1 - \varepsilon)(1 - \delta) + (1 - \delta)} B(-1) \frac{\partial p_2^0}{\partial Q} \frac{(1 - \varepsilon)(1 - \delta) + (1 - \delta)}{B(1)} \right)
\]

**Result 2:** In the case of no signed card, campaign intensity does not affect the optimal decision threshold, \(Q^*\).

Having found the optimal thresholds for both types of deceased, those who signed a card and those who did not, it is now possible to compute the total number of actual donations, \(T\), as follows:

\[
T_{(a,\gamma)} = \delta \int_{r^*}^{\infty} f_2 + \int_{r^*}^{\infty} f_1 + (1 - \delta) \int_{Q^*}^{\infty} f_2 + \int_{Q^*}^{\infty} f_1
\] (10)

Using Leibniz’s rule, we find the optimal campaign intensity, \(\delta\) to be chosen for total donations. The first order condition requires that:

\[
\frac{\partial T_{(a,\gamma)}}{\partial \delta} = \int_{r^*}^{\infty} f_2 (x) dx - \delta \left[ \frac{\partial R^*}{\partial \delta} f(R^*) \right] + \frac{\partial R^*}{\partial \delta} f(R^*) + \frac{\partial Q^*}{\partial \delta} f(Q^*) - \int_{Q^*}^{\infty} f_2 (y) dy = 0
\] (11)
Using the definitions for \( f_1 \) and \( f_2 \), first order conditions can be described as follows:

\[
(1 - p_2^g) - (1 - p_2^o) + (1 - \delta) \frac{\partial R^*}{\partial \delta} f(R^*) = 0
\]

(12)

The following implicit function gives the optimal intensity of the campaign, \( \delta^* \):

\[
\delta^* = 1 - \frac{(p_2^o - p_2^g)}{\frac{\partial R^*}{\partial \delta} f(R^*)}
\]

(13)

**Result 3:** When \( p_2^o = p_2^g \) then \( \delta = 1 \).

Result 3 implies that, when the quality of the test is equal in both groups, with quality measured by the probability of making a correct decision, then the campaign intensity will be such that everyone signs, and so the outcome is a pooling equilibrium. This means that the signal does not hold any information because \( \alpha \) is equal to 1/2.

**Result 4:** When \( p_2^o > p_2^g \) then \( \delta < 1 \).

Result 4 implies that it is not efficient to expose everyone to publicity. This is because the group of people with non-signed cards has a higher quality test and therefore it is not efficient to cause a large number of people to sign and to transfer them to the group with signed cards where the quality of the test is lower. Transferring people to the signed card group reduces actual donations because the low quality test reduces the ability to identify those who really want to donate.
When Q is a better test than R, it is not worth exposing everyone to publicity:

\textbf{Result 5:} When $p_2^Q < p_2^g$ then $\delta > 1$.

Since the boundaries of $\delta$ are between 0 and 1, and the optimal level of $\delta$ is bigger than 1, $\delta$ is assigned its highest possible value of one.

When R is a better test then Q, the optimal number of actual donations can be achieved by exposing all the population to the campaign.

The model therefore emphasizes how advertisements distort the signal of the deceased and underlie the potential for a perverse supply response when surviving family members are imperfectly informed about the true decision of the deceased. The model identifies three potential equilibria. In the first equilibrium, both tests are equal and everyone signs a donation card. In that case the signal contains no information and the families make decisions based only on their private information drawn from the behavior of the deceased. In the second equilibrium, is not efficient to expose all the population to the campaign, because the result will be fewer donations. The third equilibrium notes the trivial solution and reflects the current situation where efficiency could be achieved by exposing everyone to the campaign.

\textbf{9. Summary}

This thesis is the beginning of a more extended research program on the issue of supply of organs for transplantation. I have provided background and noted informally explanations for lack of supply, and also developed a formal model that investigates one of the means whereby it can be suggested that supply might be increased, through a
public policy of persuasion. The model has identified problems with this simple means of attempting to increase organ supply.

The issues remain highly complex in that, although the technology is quite advanced, the ethical, psychological, and economic problems involved are far from solved. The supply of organs is nowhere near the demand, and the gap is growing.

The case of Israel is special because of Jewish law and the disagreement between physicians and rabbinical establishment about determining the time of death.

Another reason for the paucity of donors is that the potential donors do not trust the medical establishment. When people volunteer altruistically, they do not want to have impure motives involved. Therefore corrupt physicians crowd out intrinsic motivation and decrease the number of donations.

The major difference between countries is in the policy of presumed consent. Countries that have a policy of presumed consent partially because people fear death and try to avoid feelings that remind them that they are not immortal whereas signing a card is a salient reminder of death. People can suppress their thoughts, and do not sign an organ donor card. These conscious and unconscious processes affect public policy.

For example, an incentive of priority for future personal need offered to potential donors may stimulate more thoughts about death, and, without an investment in information, may decrease the number of donors. The policy would thereby achieve the opposite of its intended goal.

A policy of presumed consent increases donations for two reasons. People avoid the fear of death because, from the day they are born, they are considered as potential donors. The psychological cost is incurred when they want to quit, because then they have to face the thought of death that they wish to avoid. Also, high rates of donation create a social custom or norm that can override personal preferences. Kidney exchange is only a partial solution. As far as distribution is concerned, since in market everyone has to be able to pay in order to receive a transplant, many poor people never undergo the process.
Overall, transplants are a procedure for high-income and insured people. However, should the choice of who obtains new organs also depend upon criteria of social worth? That is to say, should a doctor obtain a new organ but a prisoner be refused? Should alcoholics be denied new livers because they "deserve" what has happened to them? In a market for kidneys, sellers are poor and buyers are rich. Another problem is that of time inconsistent behavior in deciding to supply an organ. Does time inconsistency or hyperbolic discounting justify banning markets in this case, especially since organ donation is irreversible.

Public policy tries to improve the current situation with proposals for laws to provide incentive for the family of the donor. Such proposals can however cause moral hazard, because people with low incomes may kill someone or even a family member may volunteer to die in order to solve the financial problems of the family.

These various issues are part of the broader background for the issue of organ transplants that I intend to continue to study.
Bibliography


