The Regulated Market for Kidneys in Iran [1]

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Abstract: *We study the kidney market in Iran. The most effective treatment for end-stage renal disease is a kidney transplant. While the supply of cadaveric kidneys is limited, the debate has been focused on the effects of the existence of a free market for human organs. Economists as well as medical and legal researchers are divided over the issue. Iran has a unique kidney market which has been in place for over 20 years, frequently reporting surprising success in reducing the waiting list for kidneys. This paper demonstrates how the Iranian system works and estimates the welfare effect of this system.*

1 Introduction

The most effective treatment for End-Stage Renal Disease (ESRD) is a kidney transplant (Renal Replacement Therapy: RRT). The only alternative treatment is dialysis and RRT is the only way for the patient to live without needing dialysis on a regular basis. Some researchers predict that the number of patient with ESRD will reach 2 million worldwide by 2010 (Nwankwo et al., 2005). In the US, it is predicted that more than 40% of patients may die

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while on the waiting list (Matas, 2006). Xue et al. (2001) predict that more than 95,000 patients will be on the waiting list for a kidney transplant by 2010; the figure was more than 65,000 in 2007.

There are two sources for a kidney transplant, cadaveric kidneys and kidneys from the live donors. Cadaveric kidneys can be harvested either from a brain-dead patient (whose heart is still beating) or cardiacally dead patient; the latter is considered to have a lower quality. Since a normal person can live on just one kidney, she can decide to donate one of her kidneys. The incentive to donate a kidney can be altruistic or obtaining money by selling a kidney. Altruistic kidney donation is mostly a case for emotionally related donors where the donor donates her kidney to either a relative or a close friend.

In order to match a kidney from a donor with a potential recipient, their ABO and RdH blood types as well as tissues should be compatible. The ABO matching should follow the same rules that should be considered for blood transfusion, although some programs are experimenting with ABO-incompatible transplantation (Gloor & Stegall, 2007). Regarding the tissue matching, a higher proportion of tissues matched between the donor and recipient will increase the probability of a successful transplantation.

It is well documented that RRT is cost effective treatment as compared to dialysis. For example the UK national health system (NHS) data reveals that the average cost of dialysis is £30,800 per year while the cost of kidney transplantation is £17,000 following by a £5,000 annual spend on the drugs. That means over a period of 10 year (the median graft survival time: the time that transplanted kidney survives in patient's body), the average benefit of kidney transplantation, comparing to dialysis, is £241,000 per patient (UK Transplant, 2007).

In order to compare the cost of two alternatives for Iran (all data for 2008); the annual cost of hemodialysis for a patient is about Rials 47.0m[2]. The cost of a transplant operation[3] is about Rials 2.4m following by estimated Rials 40.0m annual expenditure on drugs[4]. That means from the cost of point of view the transplant is preferred and the average benefit over the 10 year period is Rials 67.6m. The higher ratio of drug costs over operation costs in Iran comparing to UK is the result of Iranian system depending on imported drugs.

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[2] By medical standards, every patients should receive thrice weekly dialysis (equivalent to 156 annual sessions), but the reported data in Iran shows that the mean annual sessions per patient is just 142. The tariff for every dialysis session is 92K ("K": medical K; which is determined by the ministry of health each year and for 2008 is Rials 3600). Then the dialysis cost will be $142 \times 92 \times 3600 \approx 47.0$m.

[3] Kidney transplantation tariff is 650K ("K": surgical K; for 2008 is Rials 3700). This value is regardless of kidney source and method of nephrectomy and includes all expenses from admission to discharge (both donor and recipient) except some special drugs that sometimes are used for patients with special conditions or in case of some complications. The costs of initial tests prior to donation or implantation are not included in this. Then the transplant cost will be $650 \times 3700 \approx 2.4$m.

[4] Different immunosuppressive regimens are used for different recipients; therefore, to determine a unique cost is somehow difficult, however considering the governmental subsidy, which these drugs receive, Rials 40m is the estimation. Donors receive no drugs routinely; unless complications happen rarely.

It is worth mentioning, the above calculations (both for UK and Iran) are only the direct benefit of the transplantation by reducing the treatment costs. Three other factors may also be considered in the cost-benefit analysis i) the opportunity cost of the time, patient spends to get dialysis treatment, ii) the improved quality of life for patient after receiving the transplant, and iii) the risk of death during the surgery for donor. Becker & Elias (2007) reports that based on several studies, the risk of death during surgery for donor is between 0.03% and 0.06%. Matas et al (2003) based on the data from the US transplant centres for period 1993 – 2001 reports the donor's death rate of around 0.03%.

It is also well known that kidneys from the live sources have a better quality as compared to the kidneys harvested from cadavers. Table 1 contains a summary of the statistics from US transplants which shows that the kidneys from live donors are more effective (NKUDIC, 2007). While the 10 year graft survival probability for live kidneys are 54.7%, the same figure for a cadaveric kidney is only 39.2%.[5] One issue that should be addressed here is the possibility that these data is affected by selection bias. In reality patients are not randomly matched to kidneys. Terminally ill patients are more likely to receive a cadaveric kidney which becomes available with lower degree of compatibility. On the other hand, patients on better conditions can wait a bit longer to receive a more compatible live donation. Then the cadaveric kidneys may show a lower graft survival not only because of its own condition but also because of the condition of recipients.

Table 1: Survival probability for different treatments

	1 year	2 years	5 years	10 years
Patient survival under dialysis	77.7%	62.6%	31.9%	10.0%
Patient survival following cadaveric transplant	94.3%	91.1%	81.2%	59.4%
Patient survival following live-donor transplant	98.2%	95.8%	90.5%	75.6%
Graft survival following cadaveric transplant	89.0%	83.3%	67.4%	39.2%
Graft survival following live-donor transplant	95.2%	91.4%	80.3%	54.7%

Source: NKUDIC (2007)

Harvesting kidneys has been a major concern for health systems all around the world in the last few decades. In order to increase the kidneys available from cadavers, two different systems adopted. The most popular one is the *opt-in system* where people, who wish to donate their organs after their death, sign up to the scheme. For example it is estimated that in the UK one in five people (more than 13 million) signed up to the scheme (Boseley, 2006). This voluntary scheme is run in many countries but usually the donor's wish is not enough to guarantee that the donation will take place after the donor's death, since in many cases the consent of next of kin is also required, either by the law or informally. There are campaigns for encouraging organ donations in many countries. However, the shortfall of the number of organs available through this system in recent years is an issue; part of the problem is the decreasing number of deaths among younger people, whose organs are most suitable. For

[5] Based on the results of a study in 2001 in Iran (not published officially), the graft survival rate in different intervals for kidney transplants are as follow: 6 months: 90.8%, 12 months: 89.1%, 18 months: 88.2%, 24 months: 87.7%, 30 months: 87.2%, and 36 months: 85.9%.

example it is claimed that one of the reasons behind the drop in the UK cadaveric kidney donation in recent years (table 2) is seat-belt legislation (Boseley, 2006).

Table 2: The number of live and cadaveric kidney transplantation 1985 - 2006

Year	Iran			Spain			UK			US		
	Live	Cadaver	Total PMP*	Live	Cadaver	Total PMP	Live	Cadaver	Total PMP	Live	Cadaver	Total PMP
1985	16		0.3									
1986	98		1.6									
1987	158		2.5									
1988	247		4.0									
1989	401		6.4									
1990	498		7.9		1240	32.2	101	1726	31.9	2094	7322	37.3
1991	571		8.9	16	1355	35.5	88	1608	29.6	2394	7281	38.3
1992	689		10.7	15	1477	38.8	101	1622	30.1	2535	7203	38.5
1993	808	8	12.2	15	1473	38.6	142	1555	29.6	2850	8170	43.5
1994	718	2	11.0	20	1613	42.5	135	1588	30.1	3007	8383	44.1
1995	790	8	11.8	35	1765	46.8	155	1615	30.8	3221	8598	46.3
1996	743	12	11.3	22	1685	44.3	183	1499	29.3	3389	8560	46.7
1997	1078	4	16.3	20	1841	46.9	179	1487	29.1	3597	8577	47.7
1998	1193	2	17.8	19	1976	50.3	252	1330	26.8	4017	8938	50.7
1999	1214	14	18.3	17	2006	50.9	270	1311	26.8	4511	8016	49.5
2000	1389	32	20.5	19	1919	48.7	348	1323	28.3	5311	8087	52.5
2001	1550	70	24.0	31	1893	46.7	358	1333	28.7	5989	8212	49.8
2002	1585	96	24.5	34	1998	48.5	372	1286	28.1	6178	8508	50.9
2003	1474	167	23.9	60	2069	49.8	451	1246	28.7	6464	8665	52.0
2004	1563	207	26.0	61	2125	50.5	463	1367	30.8	6644	9349	54.5
2005	1721	209	27.4	88	2049	48.3	543	1197	29.5	6541	9827	55.3
2006	1615	243	26.4	102	2055	48.3	671	1240	31.7	6434	10659	57.3
2007	1600	311	27.1	137	2074	49.5	804	1207	33.5	6037	10587	54.7
Ave. annual growth rate (1996-06)	8.1%	35.1%		16.6%	2.0%		13.9%	-1.9%		6.6%	2.2%	
Ave. annual growth rate (2001-06)	0.8%	28.3%		26.9%	1.7%		13.4%	-1.4%		1.4%	5.4%	

* PMP: total number of organ donations per million population

Source: IRODaT (2009)

The alternative system is the opt-out system which is practised in some European countries, including Spain and Austria. In this system, the donor's consent is presumed and a person needs to opt out the scheme if she does not want to donate her organs after death. UK also considered switching from opt-in system to this system, where it is under legal and political consideration (Wintour, 2008)[6]. One legitimate argument against this system is that presumed consent means that the state is considered the owner of the body of deceased person. Some consider this to be a problematic assumption (Becker & Elias, 2007). Abadie & Gay (2006) develop an economic model to investigate the effect of presumed consent on the donation rate, their model predicts that the opt-out system may have a positive or negative effect on the rate of donations comparing to opt-in system depending on the model assumptions, however, their empirical analysis for 22 countries over a 10-year period shows after controlling for other determinants, presumed consent legislation has a positive and significant effect on organ donation rates.

Another measure to boost the number of donations is an expansive legal definition of death, such as Spain uses, allowing physicians to declare a patient to be dead at an earlier

[6] Recently the government committee has recommended against opt-out.

stage, when the organs are still in good physical condition. This is controversial and has been mentioned as the main reason for individuals not wanting to participate in organ donation schemes. As a result of this procedure, putting extra effort and resources in procurement process, and the presumed consent system, Spain has one of the highest rates of cadaveric donations in Europe. (See Table A1 in appendix) In summary the high rate of kidney donation in Spain is due to presumed consent policy, enhanced infrastructure for donation, expansive legal definition of death, and more road accidents. However there has been no study to estimate the contribution of each factor.

There is the argument of conflict of interest in medical teams who should either declare the death or try to save the badly injured patients. For example in US, in one case a medical official was accused of trying to end somebody's life in order to harvest their organs. In another case a doctor said she was under pressure by organ procurement team, to declare a patient dead sooner than medically advisable (Stein, 2007).[7]

If the donor is a close relative or emotionally related to the recipient, live donation is legal in most of the countries around the world. The sale of organs is forbidden in all countries except in Iran, which has a regulated system for selling kidneys. However, there is evidence of the abuse of the system in many other countries. Organ trafficking in India is an example where there are reports of removing the kidneys without donor's consent (Patel, 1996)[8]. Also, there are reports that patients from wealthy countries travel to poorer countries in order to buy a kidney (Boseley, 2006) which in some cases removed from donor's body without their knowledge (Patel, 1996).

In Iran a regulated system for kidney donation with monetary compensation was introduced in 1980s. Under this regime the donor receives a monetary compensation from the recipient and enjoys additional monetary and non-monetary bonuses from the government. The system has been criticised harshly (i.e. Harmon & Delmonico, 2006 and Zargooshi, 2001) as well as receiving some warm support (i.e. Daar, 2006 and Mahdavi-Mazdeh et al., 2008) both inside Iran and internationally. Ghods & Savaj (2006) is one of the most recent papers which tries to reason in support of the system by highlighting the benefits and answering some of the critics. Data show that in 2006 1858 kidney transplantation took place in Iran. 13% and 12% of these transplants were harvested from cadaveric and emotionally related live sources respectively and the other 75% was from unrelated live donations (Pondrom, 2008).

There has been no discussion on how the system works by economists. While there were a lot of discussion in medical journals on the Iranian system (for some of the most recent ones look at Ghods & Savaj (2006), Griffin (2007), and Mahdavi-Mazdeh et al. (2008)), the lack of publication in economics journals leads to misleading quotes in other researches. For example Becker & Elias (2007) mention that Iranian government opposes the cadaveric donation on

[7] China has also been under pressure for selling the organs of executed individuals (Kram, 2001) where Chinese transplant centres openly advertise for business from foreigners (Boseley, 2006).

[8] Kidney sale was legal in India in 1980s and early 1990s and then became illegal in mid 1990s.

religious grounds which in not true. On contrary, as figures in table 2 show the Iranian government tries hard to replace the live donation with harvesting kidneys from cadavers and the number of other cadaveric organ donations is also growing fast (Pondrom, 2008).[9]

Another issue that should be addressed is the compatibility issue. There are two major considerations regarding the compatibility, blood type and tissues. Blood type of the donor and the recipient is needed to have the general compatibility rule for the blood types (which is being depicted in table 3). Even with medical achievements in recent years to overcome the compatibility issue still incompatibility raises the rejection probability in transplant. Finding an exact blood type match between recipient and donor significantly increases the possibility of success. Tissue matching is performed by testing whether a number of antigens (normally 6 antigens) are matched between recipient and donor. Higher number of matches in tissues also increases the chance of success in transplant.

Table 3: The compatibility rule for blood and organ donation

		Donor							
		O+	A+	B+	AB+	O-	A-	B-	AB-
Recipient	O+	↵				↵			
	A+	↵	↵			↵	↵		
	B+	↵		↵		↵		↵	
	AB+	↵	↵	↵	↵	↵	↵	↵	↵
	O-					↵			
	A-					↵	↵		
	B-					↵		↵	
	AB-					↵	↵	↵	↵

In this paper we try to establish clearly how the Iranian regulated system works, find facts using the data collected from one of procurement centres in Tehran, and explain the welfare effect of this market on all parties involved. Our finding shows the average waiting time in Iranian system is around 5 months. This can be considered a great success compared to average waiting time in other countries.

Following we start with a brief review on the economics literature on organ donation in section 2. In section 3 and 4 we demonstrate Iran's case and present the data collected from one of the procurement centres. In section 5 a theoretical model will be introduced following by conclusion in section 6 which includes our findings and policy implications.

2 Literature Review

[9] Research grants are also allocated by the Iranian government for research on cloning in order to be used in organ procurement. There is no significant opposition from religious leaders or other social pressure groups, but it is very unlikely that these researches lead to a significant breakthrough for organ procurement in the next decade, not only in Iran but also worldwide (Ghods & Savaj, 2006).

Economists have made contribution to the organ donation literature in two fields. First, the kidney market and issues associated with that. The other is designing a mechanism to resolve the compatibility issues where donor and recipient are selected.

2.1. Kidney Market

Discussion on buying and selling organs or parts of human body (including blood) can be done on four grounds: medical, moral, legal, and economic grounds. Top medical experts do not agree on whether the organ market can be implemented or should be banned.[10]

From the medical point of view, the evidence as presented in introduction shows that live donation is efficient and cost effective. Furthermore, if it is safe to be performed on an emotionally related donor, there should be no medical concern for a kidney market on the medical grounds. The only point would be to ensure the system puts the donor's welfare before the recipient's; the same rule which should be considered for an emotionally related pair.

We are not going to discuss moral issues surrounding the kidney sales in full details in this paper. Roth (2007) explains how the ethical and moral belief of majority of a society may affect the market as repugnance.

The legal discussions usually concentrate on answering the question of whether an individual has the right to sell one of her organs or not. For an economist, it might seems quite a reasonable assumption that one's body can be considered as their own property, but defining a property framework for the human body is one of the fresh lines of research in *medical ethics*. (i.e. Quigley, 2007)

The early discussion on the economics of a market for human body parts goes back to 1970 when Titmuss argued that buying and selling blood has an adverse effect on the quality of the blood (Titmuss, 1997). Titmuss compares the data from the British system (where paying for the blood was illegal) with the American system (where blood donors got paid) and argues that the latter had a lower quality of denoted blood. Titmuss points out that a significant fraction of the American blood came from individuals with hepatitis and other diseases that could not be screened out, and the blood given under the British system tended to be healthier. Titmuss also argued that monetary compensation for donating blood might reduce the supply of blood donors. This hypothesis often referred to as *crowding out* effect. Titmuss predicts that people will give blood mainly for altruism and introducing money compensation into the system is going to diminish their incentives for blood donation.

Becker (2006) argues that even if Titmuss was right about the quality of the blood, the American system provides more blood per capita than British system. This means that the crowding out effect is not present. However, the quality of blood is not a major problem now, since the modern screening methods can guarantee the blood is not contaminated. In case of

[10] Some of the most recent arguments for and against the idea can be found respectively in Reese et al. (2006) and Danovitch & Leichtman (2006).

kidneys, one can argue that medical developments can determine the well-being of the donor and recipient. On the other hand, since kidney transplant is a more complicated and costly procedure comparing to blood transfusion, the initial test for the donor in order to assess the quality of the kidney, as well as the donor's safety and welfare, would be more justifiable.

Mellström & Johannesson (2008) ran a field experiment on the blood transfusion system in Sweden to examine whether the crowding out effect can be determined. They designed three treatments. In the first one, subjects are given the opportunity to become blood donors without any compensation. In the second treatment subjects receive monetary compensation (SEK 50 ≈ $7), and in the last one subjects can choose to receive the payment or donating it to charity. Their experiment shows evidence for the crowding out effect only on some part of population (women) which will be eliminated if the monetary payment made to charity rather than the individual.

Cohen (1989), Epstein (1993), and Kaserman & Barnett (2002) discuss the monetary compensation for cadaveric organ donations but Becker & Elias (2007) are the first to calculate a price for live kidneys. They calculate a price of a kidney (and a liver) based on three monetary compensations i) compensation for the risk of death as a result of donation, ii) compensation for the time lost during recovery, and iii) compensation for the risk of reduced quality of life. They suggest a price of $15,200 for a kidney. They also point out that if the market for cadaveric kidneys established alongside the live kidney market, most kidneys will come from cadavers and live kidney prices works as a benchmark for the market equilibrium price for cadaveric kidneys.[11]

2.2. Kidney Exchange Mechanisms

One of the main restrictions for emotionally related organ donations is the compatibility issue, where the donor's kidney cannot be transplanted for their intended recipient. But it might be compatible with another patient who also has a non-compatible donor.

Roth et al. (2004) introduce a kidney exchange mechanism which efficiently and incentive compatibly, can increase the number of transplants within existing constraints. Their model resembles some of the housing problems studied in the mechanism design literature for indivisible goods (i.e. Shapley & Scarf, 1974 and Abdulkadiroglu & Sönmez, 1999). Modified versions of their model, in order to limit the number of simultaneous operations needed, with constraint on the maximum number of donor-patient pairs to two or three, has been developed in later papers (Roth et al., 2005b; Roth et al., 2007; and Saidman et al.,

[11] If Becker & Elias (2007) suggestion for paying for cadaveric kidneys and livers is going to be practiced; one issue, which should be addressed, is its effect on health costs of other transplantations from cadaveric sources, like hearts and corneas. Currently no payment has been made for harvesting these organs which under the new system it seems plausible to assume they should be priced as well. One argument can be since the demand for these organs are not as high as kidney and liver the equilibrium price will not be significantly high and the altruistic donation may be enough to cover the demand. However, this issue can be subject of a separate research.

2006). Roth et al. (2005a) provides evidence from the experiment of opening a kidney clearinghouse in New England, US.

In an exceptional case a 6 way exchange performed in the US on April 2008 (BBC, 2008). However, because of practical issues (the exchange operations should be done simultaneously and most possibly at the same hospital) as well as incentive issues (where medical teams should work together and it is most likely doctors in small hospitals should refer almost all of their patients to other centres) the exchange mechanism cannot provide enough kidneys to overcome the shortage.

3 Iran's Case

3.1. Background

The 1979 revolution in Iran was followed in 1980 by an eight year war with Iraq. Dialysis equipment was scarce because of economic sanctions and lack of funds for imports (Nobakht & Ghahramani, 2006). As a result of these events, nephrologists were encouraged to perform kidney transplants. At the beginning, the process relied on few cadaveric kidneys available, along with emotionally related donors. But the large number of patients on the waiting list forced the authorities to establish a regulated market for living unrelated donations. The efforts of charities, established and managed by dialysis patients and their close relatives, helped to develop the market. Table 2 shows a clear picture of the development of kidney transplantation in Iran. It is notable that over a period of 10 year (1996-2006) the rate of cadaveric and live donation increased by 35.1% and 8.1% annually. Cadaveric transplants accounted for 1.6% of total number of transplantation in 1996, this figure reached 13.1% in 2006.

3.2. Institutions

There are several bodies involved in kidney procurement for patients in need of a kidney transplant in Iran:

1) *Kidney Foundation of Iran* (or *Dialysis and Transplant Patients Association* (DATPA)) is a charity founded by some of kidney patients and their relatives about 20 years ago. The foundation is a non-governmental organisation and helps kidney patients with their problems. With 138 branches around the country, they help kidney patients with medical, financial, and other problems. In about 10 centres they have kidney donation offices. Their main and busiest office is located in Tehran. The foundation also has official support of the *Charity Foundation for Special Diseases*.

2) *Office of the Governor of Tehran* (Ostan-dari) has also an office for kidney donation which has limited activities comparing to the Kidney Foundation. There are similar offices in some other provinces located in the governors' headquarters.

3) *Management Centre for Transplantation and Special Diseases* which is part of the *Ministry of Health and Medical Education* and is responsible for cadaver transplant. This

centre has different waiting lists for patients in need of various organs for transplantation and is the main (and only) centre involved in procurement of organs from cadavers. The centre's database ran nationally. When cadaveric organs of a deceased patient become available, the centre allocates the organs (including kidneys) to transplant centres around the country considering different factors including distance and waiting time.

In summer 2007, there were around 1000 patients on their waiting list for kidney transplant. As it can be seen in table 2, in 2005 from 1854 kidney donation, 243 cases were from cadavers. That means around 13% of the kidneys come from cadaver sources. Religious and traditional views are a major barrier for cadaveric donations, however, in recent years the numbers of cadaveric of transplants is increasing. A scheme of donor registry (opt-in system) is designed and some individuals, especially young educated Iranians, have shown interest in signing to the scheme. But in practice the relatives of the dead person have veto power and they can overrule the original decision made by the person herself, as it is the case in many other countries with the opt-in system (Abadie & Gay, 2006).

3.3. How Does Unrelated Kidney Donation in Iran Work? [12]

The Kidney Foundation keeps waiting lists for kidney patients with different blood types in each of its procurement offices. There are eight different lists for different blood types (see table 3). A kidney patient, who wishes to be added to the waiting list, needs to present a letter from his doctor. Since the foundation does not run any initial tests on patients, some patients may enter the list when they are not medically ready for a transplant. This may cause unintended delays in the matching process. A patient should be at a certain stage of the kidney failure disease to be considered ready for the transplant; and his general physical conditions (for example strength or minimum weight) also play a significant part in increasing the probability of success in operation. A patient is given priority in the waiting list, if he either is medically in an emergency situation (as assessed by his doctor) or is a disabled soldier[13].

There is no centralised waiting list and each centre has its own waiting list. Patients are asked by foundation to book in their nearest centre but some patients enter several waiting lists (including the cadaveric waiting list) in order to minimise their waiting time. However, the centres coordinate with each other in case of imbalances (especially for emergency cases) of demand and supply for kidneys with a particular blood type.

Medical staff including the members of the transplantation team have no role in identifying potential donors. When a donor (aged between 22 and 35)[14] turns up to donate her

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[12] This section is based on our interviews with the foundation staff, other sources and some published papers.

[13] Mostly injured in the eight year war with Iraq (1980-88).

[14] The reason for the age cap is considered to be a higher chance of the graft survival. Some researches on live donation do not support that the lower the age of the donor has a significant relationship with higher graft survival period. For example El-Agroudy et al (2003) shows that the average age for the live donor when kidney survived for more than 15 years was 30 ± 8.6 while for the graft survival rate less than 15 years was 35 ± 10.7. Another research (El-Husseini et al., 2006) reports for a 10 year graft surviving period, these figures

kidney, she needs to provide certain documents; including a formal consent from either her spouse or her father (in case of un-married donors)[15]. After the initial official paperwork, she will be referred to a clinic for the initial medical tests. The foundation office in Tehran has its own clinic which is used in order to offer medical support for kidney patients. Using this clinic speeds up the initial process. These tests determine whether the potential donor has any sort of kidney problem as well as a simple blood test and whether her kidney has two renal arteries[16]. If the transplantation team suspected any possible harm to the donor either now or for the future, the donation will be cancelled. The costs of these tests, which are not high, have to be paid by the donor herself. Since the cost of these tests (estimated around Rials 50k) is not significantly high comparing to the monetary compensation, it does not seem to have an adverse effect on donors' decision.

After the donor passes the initial tests, the administrators contact the first patient in the same waiting list as the donor's blood type. In this stage the staff also has in their mind to match the physical build of the donor and the patient or at least make sure that they are not extremely different. This also raises the issue of finding a suitable match for child patients which is difficult. Matches cross different blood types are rare and they try to match the blood type of the donor and the recipient. Since having the same blood type is going to increase the possibility of a successful transplant (comparing to alternative transplants between compatible blood types), usually the doctors also advise their patients to wait for an exact match.

If the patient who is on the top of the waiting list at the moment is not ready for the transplant at that moment, the next patient will be called, and so on, until a ready patient will be found. Then a meeting between the two parties is arranged (they are provided with a private area within the foundation building if they want to reach a private agreement) and they will be sent for tissue tests. If the tissue test gives the favourable result[17], a contract between the patient and the donor will be signed and they will be provided with a list of the transplant centres and doctors who perform surgery. When the patient and the donor are referred to transplant centre, a cheque from the patient will be kept at the centre to be paid to the donor after the transplant takes place. The guide price has been 25m Rials (≈ $2660) until March 2007 for 3 years and at this time[18] it has been raised to 30m Rials (≈ $3190).[19] This decision has been made because the foundation was worried of a decreasing trend in number of donors.

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as 37.1 ± 9.4 and 36.2 ± 8.5 respectively. However, it always will be the case that any operation (like being a kidney donor) is considered with a substantial risk after an age threshold.

[15] In Absence of next of kin, to make sure the donor is aware of her action and its consequences, she will be referred to a chartered psychologist at the coroner's office for a psychic test.

[16] Most patients are not happy to have a kidney transplant from this type, since it reduces the chance of successful transplant. However, some researches show no difference regarding this (Makiyama et al., 2003).

[17] According to administrators of the foundation less than 10% of the tests have a positive cross-match which effectively rules out transplantation. It should be noted that the more tissue matching factor leads to a higher probability of success.

[18] The Iranian new year starts at 20 March. The adjustment happened at the start on new year.

[19] The exchange rate for 20 Feb 2008: $1 ≡ Rials 9410; £1 ≡ Rials 18400.

In some cases, the recipient will agree to make an additional payment to the donor outside the system; it is not certain how common this practice is, but according to the foundation staff the amount of this payment is not usually big and is thought to be about 5m to 10m Rials (≈ $530 to $1060). The recipient also pays for the cost of tests, two operations, after surgery cares, and other associated costs (like accommodation and travel costs if the patient travels from another city). Insurance companies cover the medical costs of the transplant and the operations are also performed free of charge in state-owned hospitals.

In addition, the government pays a monetary gift to the donor for appreciation of her altruism (currently, 10m Rials), as well as automatic provision of one year free health insurance[20], and the opportunity to attend the annual appreciation event dedicated to donors[21]. The *Charity Foundation for Special Diseases* also provides the donors with a free annual medical test and high level of support, in case that the donor develops kidney problems in the future, regardless of whether this is due to the transplant or not.

Emotionally related donors also enjoy these monetary and non-monetary bonuses as well as exemption of paying hospital costs, and it gives them a good incentive to register in the foundation offices.

The minimum monthly legal wage for 2007 was Rials 1,830k (later raised to 2,200k for 2008). The minimum payment of Rials 45m is around 2 years of minimum wage.[22]

The minimum current payment (45m Rials) by using PPP exchange rate[23] is equivalent to $14,000 which is interestingly close to Becker & Elias (2007) suggestion for the market value of a kidney at $15,200 for the US. In 1980s when the sale of kidney was legal in India, donors were paid $1,603. After making this illegal in 1990s the average payment dropped to $975 (Goyal et al., 2002). Based on this paper and other researches, Becker & Elias (2007) estimate that the equivalent cost of a kidney in Indian market to US dollar in 2005 is in region of $17,078 to $17,665. However, they even report a price of around 50,000 Rupees in 1980s which with their calculations will be equivalent to $81,510 in the US market for 2005.

The government decision to ease the process by legislation and monetary and non-monetary bonuses seems reasonable. The social negative effect of losing ESRD patients who are usually at working age and most possibly parents of underage children is quite significant. This decision is also justifiable on economic grounds, from the government and insurers point

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[20] Nobakht & Ghahramani (2006) claim that the donors are provided with a free life-long insurance which is in contrary with our findings, after interviews with the foundation staff.

[21] This event is an event to celebrate the altruism of family of cadaver organ donors as well as living kidney donors. Among the guests are also all the organ recipients. The events gather a very good publicity in media; usually to emphasis the importance of cadaveric donors.

[22] This figure is the minimum wage which is well below the minimum cost of living. The Iranian Central Bank reports the monthly average cost of living for a family of four to be Rials 8.7m for Tehran and Rials 6.64m for other urban areas. This makes the minimum compensation equivalent to 5.2 to 6.7 months of average cost of living in urban areas.

[23] For PPP exchange rate an average of indexes suggested by IMF, and World Bank is used.

of view. A patient, who is going under constant dialysis, is going to spend a lot of time out of the job. Adding up to this opportunity cost, the financial burden for the dialysis on the patient, his family, social services, and the government and considering a higher probability of death while in the waiting list, having no option for live transplant; shows the high alternative cost for the society.

Advertising for kidney donors is banned. However, some patients manage to find donors from other informal channels in order to avoid the waiting list. The foundation handle these cases with due care and such cases need to be reviewed by the foundation managing director. However, since the bonus payment appreciation and other protections by the government are in place for donors, then any donation that takes place is registered in one of the foundation offices around the country. This includes most of donations from family members which recipient and donor do not involve in any financial transactions.

In order to prevent international kidney trade, the donor and recipient are required to have the same nationality. That means an Afghan patient, who is referred to the foundation, should wait until an Afghan donor with appropriate characteristics turns up. This is to avoid transplant tourism. Transplant tourism seems to be a problem in India (Patel, 1996). Another issue can be Iranian nationals residing abroad and travel to Iran to buy a kidney, which is allowed under current legislation.[24]

Although the insurance companies will not cover the donor's compensation, poor recipients can get help in order to provide the cost from different charities. The foundation staff also have an informal list of generous volunteers, who are eager to help poor patients financially.

By the foundation's procedure to keep 8 different waiting lists, if one assumes that the blood type distribution is the same between patients and potential donors then the waiting time would be fairly similar for all waiting lists, furthermore there will be no significant social benefit in matching between blood groups.

One of the concerns about employing the Iranian system would be the possible welfare effect on the minorities because of the different pattern of the blood type distribution in their blood types. Table A2 shows the blood type distribution of blood donors in different provinces. This data shows only the geographical distribution of the blood donors and usually is biased in favour O and negative blood types, since usually blood transfusion centres encourage these types of blood types to be donated more. However, looking at these data one line of the fresh research in Iranian system would be to investigate the proportion of different

[24] Official statistics show that around 1m refugees live in Iran mostly with Afghan and Iraqi origins (Some claim the actual figure is far more and in some stages over the past 20 years has even reached to around 3 million). Ghods and Savaj (2006) refer to a study on nationality of transplant recipients and kidney donors. From 1881 kidney transplants, 19 (1%) recipients were refugees, and 11 (0.6%) were other foreign nationals who received kidneys from living-related donors or from living-unrelated donors of the same nationality. Of 1881 recipients, 18 (0.9%) also were Iranian immigrants (residing abroad for years) who came and received kidneys from Iranian paid donors. The scale of transplant tourism is very small in Iran.

ethnic and race minorities in the pool of kidney donors and recipients. Walter et al. (1991) summarises the result of few other researches in Iranian ethnic variability of blood type frequencies based on ABO alleles (Their finding can be found on table A3). Since their divisions in Iran population is neither consistent (have some geographical division and some ethnic minorities) nor inclusive (do not show a clear picture of the whole country) their findings can be addressed as another source of concern for this issue. They specially point out that Assyrian, Armenians, Zoroastrians, Jews, Turkmans, and Arabs, all religious and ethnic minorities, show a significant different pattern of ABO frequencies, however, they report a significantly lower percentage of O alleles for all of these minority groups than the Iranian average.

There are two major papers which address the donors' satisfaction issue. Zargooshi (2001) surveys 300 of kidney donors. They donated between 6 to 132 months ago. He finds that the majority of donors either did not receive or did not attend follow-up visits. Many of them regretted their original decision. On contrary Malakoutian et al (2007) report a 91% satisfaction between living kidney donors. However, the latter survey is asked the donors at the point of discharge from hospital.

4 Data

Our data contains 598 transplantations recorded in Tehran office of the Kidney Foundation between April 2006 and December 2008. In fact, this is the number of patients who withdrew from the waiting list with a kidney transplant in these 21 months. Of these, 549 were live kidney donations of which 539 were traded kidney and 10 emotionally related donations. The remaining 49 transplantations took place with a cadaveric donation. In theory the waiting lists for live and cadaveric kidneys run independently; and the coverage of our data from cadaveric transplant is not complete. While our data shows a 8.2% share for the cadaveric transplantations, which is slightly lower than around 13% on average from table 2. Having in mind that our data is only a subset of total transplants, this can be addressed by the number of patients who only sign in the cadaveric lists and not in the living waiting lists.

The number of traded kidneys only includes the matches that the recipient and the donor both were registered in Tehran office. Since for other matches were either patient or the donor are found by other offices they did not have a complete profile of both parties. The foundation office in Tehran does not have a computerised database at the moment, and the data was produced by going through the files of every individual match, that has been made.

We now demonstrate our findings from the data. It is clear that our finding can not be a good image of what is happening in terms of emotionally related donations, because of the small number of this type of donations in our sample.

Table 4 shows the ABO and RhD blood types distribution of recipients.

Table 4: The ABO and RhD blood types distribution of recipients

	Blood Type								
	O+	A+	B+	AB+	O-	A-	B-	AB-	**Total**

Traded	150	165	110	38	27	34	10	5	**539**	90.1%
Non-Traded	3	2	2	1	0	1	1	0	**10**	1.7%
Cadaver	15	15	11	2	1	3	2	0	**49**	8.2%
Total	**168**	**182**	**123**	**41**	**28**	**38**	**13**	**5**	**598**	

In Order to check whether the traded kidneys are biased in favour of AB blood type and are disadvantageous for O type, table 5 demonstrates the ABO blood type distribution of recipients. Although the share of AB recipients is higher in traded cases but there is no significant difference for the share of O recipients in traded and cadaveric cases.

Table 5: The ABO blood type distribution of recipients

	Blood Type				
	O	A	B	AB	**Total**
Traded	32.8%	36.9%	22.3%	8.0%	**100%**
Non – Traded	30.0%	30.0%	30.0%	10.0%	**100%**
Cadaver	32.7%	36.7%	26.5%	4.1%	**100%**
Total	**32.8%**	**36.8%**	**22.7%**	**7.7%**	**100%**

Another concern could be discriminating against women in receiving kidneys. Traditionally in Iran, men are referred as breadwinner of the family. Although the sex pattern of labour force has been changed, but it is still biased towards a higher proportion of male workers. Since in this view, the economic value of a man is considered to be higher, one consequence in our argument can be a higher likelihood for a male patient receiving a kidney from traded sector. Table 6 shows the number and percentage of male and female recipients. The figures do not support any negative effect on female patients in our data.

Table 6: The sex of recipients of each type of kidney

	Male	Female	Total
Traded	350 (64.9%)	189 (35.1%)	539 (100.0%)
Non-Traded	5 (50.0%)	5 (50.0%)	10 (100.0%)
Cadaver	33 (67.3%)	16 (32.7%)	49 (100.0%)
Total	**388**	**210**	**598**

On the other hand the donors are mostly men (Table 7). This can be because of the two facts. Firstly, the ages between 22 and 35; when the donation is accepted; is the fertility age; and women are less likely to be considered as potential donors. Secondly, as we mentioned before since men are supposed as the main breadwinner of the family, it is more likely that they sell their kidneys in order to overcome financial difficulties. Female donors count for around 18% of traded kidneys in our data; it is in contrary with the Indian case where 71% of the sold kidneys were from female donors (Goyal et al. 2002).[25]

[25] Indian data needs to be treated very carefully, since the kidney sale is illegal. However, the difference between two figures is quite significant.

Table 7: The sex of donors of each type of kidney

	Male	Female	Total
Traded	446	93	539
Non-Traded	4	6	10
Total	**450**	**99**	**549**

Table 8 demonstrates the age distribution of recipients and donors of traded kidneys. It shows that 10.9% of the recipients are under the age of 20. Finding kidneys for child patients is one of their main problems. The kidneys for these children should be small in size, and usually women donors are the best to match for these patients. The high number of transplants needed for relatively young patients (42.9% under the age of 40 and 65.3% under the age of 50), shows the economic and social value of these transplants. Although the foundation's policy is to limit the donors' age to 35, 10.4% of the donors are older than 35.

The joint blood type distribution of recipients and donors can be seen at table 9. On average 94.8% of kidneys are matched to an exact blood type. In total 28 cases out of 539 are matches between different blood types. The reason behind this can be emergency cases, matches found by patients themselves out of the formal system, and especial cases (like children recipients when the size of kidney plays an important rule).

Table 8: Age distribution of recipients and donors

Age	Recipients		Donors	
5 – 9	12	2.2%		
10 – 14	19	3.5%		
15 – 19	28	5.2%		
20 – 24	36	6.7%	148	27.5%
25 – 29	50	9.3%	216	40.1%
30 – 34	42	7.8%	119	22.1%
35 – 39	44	8.2%	51	9.5%
40 – 44	59	10.9%	5	0.9%
45 – 49	62	11.5%		
50 – 54	58	10.8%		
55 – 59	65	12.1%		
60 – 64	40	7.4%		
65 – 69	16	3.0%		
70 – 74	7	1.3%		
75 – 79	1	0.2%		
Total	**539**	**100.0%**	**539**	**100.0%**

Table 9: Joint ABO and RdH frequency of transplants for recipients and donors

		Donor									
		O+	A+	B+	AB+	O-	A-	B-	AB-	**Total**	
Recipient	O+	149				1				**150**	27.8%
	A+	2	163							**165**	30.6%
	B+	4		104				2		**110**	20.4%
	AB+		1	1	36					**38**	7.1%
	O-	7				20				**27**	5.0%

	A-	1	4			3	26			**34**	6.3%
	B-							10		**10**	1.9%
	AB-				2				3	**5**	0.9%
Total		**163**	**168**	**105**	**38**	**24**	**26**	**12**	**3**	**539**	100.0%
		30.2%	31.2%	19.5%	7.1%	4.5%	4.8%	2.2%	0.6%	100.0%	
Own type		91.4%	97.0%	99.0%	94.7%	83.3%	100.0%	83.3%	100.0%	94.8%	

The average waiting time for patients who receive a live kidney is 149 days (Table 10). By waiting time, we mean the time gap between signing into the waiting list and the operation date. This includes the time needed for the tests and preparation before the transplant when a match initially introduced.

Assuming a similar distribution in donors and recipients population over the blood types, waiting time is expected to be the same for all waiting lists. However, the waiting time for a given waiting list is going to be affected by the following:

- Not enough donors from that blood type turn up comparing to other blood types; it can be serious when one blood type is rare; like AB- for the Iranian population.

- When kidneys from a blood group is offered to other matching blood groups. In our data, type O+ recipient is likely to be slightly affected by this, as the waiting time for them 171 days (22 days more than the average). 8.6% of this type of kidney is allocated to other blood groups.

- When a patient enters before he is medically ready for the transplant; we cannot check for this in our data.

- When a mismatch arises in testing procedure which means a 2-4 weeks is added to waiting time of the next recipient of this kidney. However, we can assume this has a similar effect on all waiting lists.

- As mentioned before the guideline price increased by 20% on March 2007. But our data shows no significant change in the waiting time or the number of donation. It could because of two reasons; firstly this increase has almost no significant effect in real term because of inflation[26]. In fact considering the inflation the official level of payment has been decreased over the 3 years when it has been capped prior to March 2007. Secondly the price that actually paid in each case can be different from this benchmark by two parties' negotiation process and it can also make that increase less significant.

Table 10: Average waiting time for recipients based on the blood type of both parties

		Donor								
		O+	A+	B+	AB+	O-	A-	B-	AB-	**Average**
Recipient	O+	169				461				**171**
	A+	110	138							**137**
	B+	85		138				214		**138**
	AB+		104	32	128					**125**

[26] The reported rate inflation for 2006-07 is 18.4%.

	O-	163				117				**129**
	A-	92	205			249	177			**184**
	B-							124		**124**
	AB-				218				144	**174**
Average		**163**	**165**	**139**	**137**	**133**	**148**	**177**	**139**	**144**

Considering all of the mentioned factors, having a waiting list of around 5 months in Iranian system comparing to more than 3 years for some other countries seems a significant achievement. One question that may arise (also by looking at tables 2 and A1) is that the overall rate of kidney transplantation in Iran is not particularly higher than its European and north American counterparts, then why the Iranian waiting lists is much shorter. The fact is that the rate of ESRD patients in Iranian population is lower as well. One of the main reasons behind this can be the Iranian population structure, in 2006 (latest census) 60.5% are below 30 and 86.1% are below 50 years old (SCI, 2007). It is estimated that in 2005, 1505 per million population (pmp) in North America, 585 pmp in Europe, and 370 pmp in Iran suffered from ESRD. (Grassmann et al., 2005)

Following, we list the possible policy considerations:

- Since the donors might be subject to exploitation because of their social status; it needs to be guaranteed that they make an informed decision and are aware of all risks attached to their decision.

- After donation networks needs to be strengthened in order to make sure the donors receive the best support possible.

- Considering the Iranian population structure, it is expected that the demand might rise for kidneys in coming years and decades. Then, more efforts need to be put on other sources of kidneys. Cadaveric kidneys can be utilised more effectively. Unlike some developed countries, Iran faces no social barrier in new frontiers in medical research, e.g. cloning. Investing in this area may help to eliminate the demand for live donation in the future.

- A national waiting list can reduce the waiting time as well as improving pre- and post-surgery support for both donors and recipients.

5 Model

Suppose we have a continuum population with the total mass normalised to one. Let there be two blood types *X* and *Y*, with shares of α and $1-\alpha$ of the population respectively. The probability of a person being in need of a kidney is *r* regardless of her blood type, however a shock of δ is considered for demand of type *X* kidneys; which can be positive or negative.[27] We assume that the demand for each type of kidney can be written as:

[27] The shock is only considered for type *X* kidneys. From the overall welfare point of view analysis of a positive (negative) shock to demand for type *Y* kidney is equivalent to a negative (positive) shock to type *X*. However, the effect in welfare on each market can be different which is not important for our discussion here.

$$q_X^D = (1+\delta) r\alpha \, \mathrm{g}(P_X) \qquad \text{and} \qquad q_Y^D = r(1-\alpha) \, \mathrm{g}(P_Y) \qquad (1)$$

$$\text{where} \quad 0 < \alpha < 1\,; \quad 0 \le r \ll 1\,; \quad -1 \le \delta \ll \frac{1}{r} - 1\,; \quad \mathrm{g}' < 0\,; \quad \mathrm{g}(0) = 1$$

Assume that type *X* kidney cannot be donated to type *Y*, but type *Y* kidneys can be donated to type *X* recipients. Suppose the income distribution is independent of blood types, so the supply has the same functional form for both types. Then the supplies can be written as:

$$q_X^S = \alpha \, \mathrm{f}(P_X) \qquad \text{and} \qquad q_Y^S = (1-\alpha) \, \mathrm{f}(P_Y) \qquad (2)$$

$$\text{where} \quad \mathrm{f}' < 0$$

In the absence of the shock ($\delta = 0$), the equilibrium price for both markets is the same $\mathrm{f}(\hat{P}) = r \, \mathrm{g}(\hat{P})$.

We assume that the regulator observes all the parameters of the market except the shock. Furthermore the regulator is able to allocate the kidneys efficiently. That means even if the market price is less than market clearing price, patients with the highest priority (highest willingness to pay) will receive kidney and the maximum feasible consumer surplus will be achieved. The regulator sets a uniform price for both markets. This price is equal to the market clearing price in the absence of the shock. The regulator is now faced with the problem whether to allow trade between the markets or not.

Negative shock ($\delta < 0$):

At the price set by the regulator ($\hat{P}$) there is now excess supply of type *X* kidneys. Since type *Y* cannot receive type *X* kidneys, the equilibrium in the *Y* market remains unchanged. In the *X* market the quantity reduces. Figure 1 shows this situation where D and D' are the original demand and demand in presence of a negative shock, respectively. Allowing the intra-trade is making no difference on the outcome and social welfare in this case. However, since the regulatory price is now higher than the market-clearing price, total welfare is reduced. The highlighted area in figure 1 shows this loss.

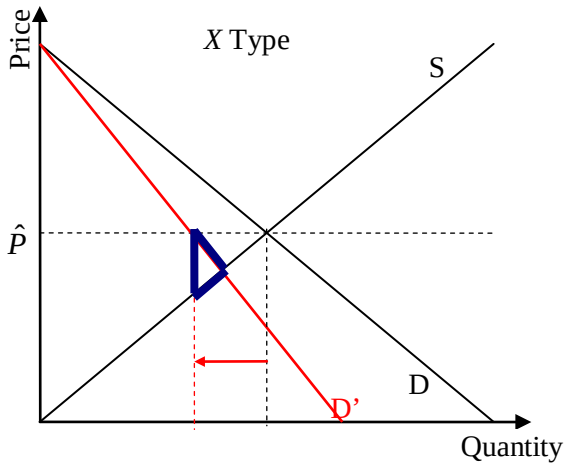

Figure 1: Demand and supply in *X* type markets

in presence of a negative shock to demand for *X*

Positive shock ($\delta > 0$):

At the price set by the regulator $\hat{P}$ there is now excess demand for type *X* kidneys. If intra-trade between the two markets is allowed, some of type *Y* kidneys will be sold in type *X* market. In order to achieve the maximum welfare in this case some of the *Y* kidneys should be allocated to *X* patients. *Y* kidneys should be allocated to *X* recipients until the marginal willingness became the same in both markets (dashed red line in figure 2). Figure 2 compares the gain and loss in consumer surplus in *X* and *Y* market. The graph to the left demonstrates type *X* market where D and D' representing demand in absence and presence of a shock respectively. The right graph presents the case for type *Y*. The two arrows show the welfare-improving shift in supply after a positive shock to demand for *X*. The two marked areas shows the gain and loss resulted by intra-trade.

Allowing the intra-trade has no effect on the supplier surplus. The consumer surplus gained by type *X* patients overweighs the loss in type *Y* patients' consumer surplus. Overall patients' welfare improves as a result of intra-trade in case of a positive shock to demand for *X*.

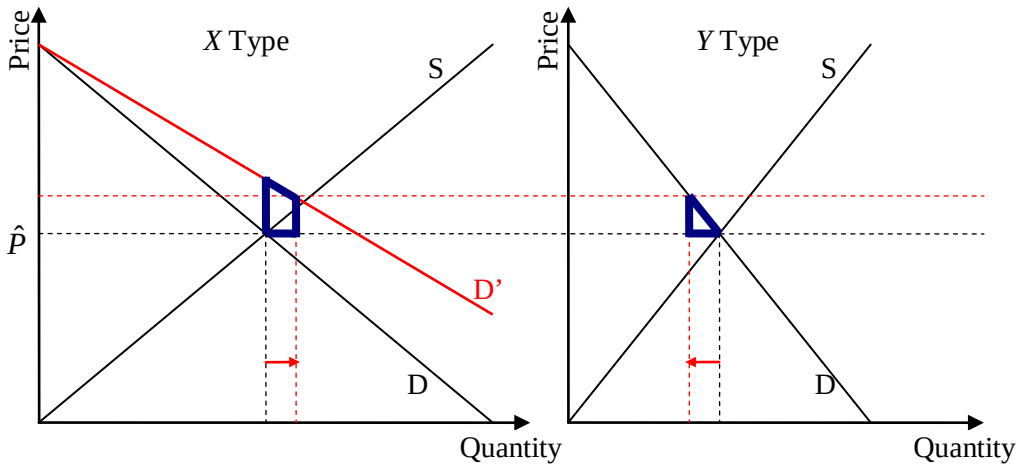

Figure 2: Demand and supply in two blood-type markets

in presence of a positive shock to demand for *X*

It is worth mentioning even if the regulator sets a price different from the equilibrium price; still this welfare analysis is true. In presence of a positive shock to demand for *X*, Whatever the price set by the government, allowing intra-trade reduces the consumer surplus for type *Y* and consumer surplus for type *X* increases. The latter always dominates and the outcome is a higher social welfare resulted by intra-trade.

6 Summary and Conclusion

In this paper, we investigate how the Iranian kidney market works. Our focus was not on the moral and ethical issues surrounding the discussions. The effect of the Iranian system on

reducing the waiting time for patients is significant, which based on our data it is around 5 months. One should be careful in advising to ban the sale at all. The alternative solution practiced in other developing countries, e.g. black market for organs, might have dramatic consequences. This may result lower standards on medical conditions, as well as leaving the donors who can be vulnerable without any official support.

We showed that allowing intra-trade between different blood types although has a negative effect on the welfare of some patients, but is going to improve the social welfare.

Appendix

Table A1: Number of kidney transplants per million population for some countries in 2006

PMP (per million people)

Country	Live	Cad.	Total	Country	Live	Cad.	Total
Cyprus	54.3	11.4	65.7	Poland	0.5	23.5	24.0
US	21.6	35.7	57.3	Slovenia	0.0	24.0	24.0
Austria	7.0	41.5	48.5	Argentina	4.9	16.7	21.6
Spain	2.3	46.0	48.3	Israel	7.7	12.4	20.1
Norway	17.1	28.1	45.2	New Zealand	11.3	8.4	19.7
Belgium	4.0	40.6	44.6	South Korea	14.1	4.9	19.0
Uruguay	2.5	41.8	44.3	Greece	5.7	13.1	18.8
France	4.0	38.0	42.0	Puerto Rico	3.5	15.3	18.8
Malta	10.0	30.0	40.0	Mexico	13.7	4.6	18.3
Netherland	17.1	22.1	39.2	Lebanon	16.0	2.0	18.0
Finland	0.6	38.3	38.9	Brazil	9.6	8.2	17.8
Portugal	3.8	33.2	37.0	Lithuania	1.8	15.9	17.7
Canada	15.0	21.5	36.5	Colombia	1.9	13.4	15.3
Czech Rep.	3.2	33.1	36.3	Pakistan	15.1	0.0	15.1
Switzerland	15.7	19.9	35.6	Estonia	0.7	13.4	14.1
Ireland	1.0	32.4	33.4	Turkey	10.1	4.0	14.1
Denmark	10.7	22.1	32.8	Brunei	13.4	0.0	13.4
Latvia	0.0	32.6	32.6	Cuba	0.7	9.9	10.6
Germany	6.3	25.8	32.1	Romania	7.9	1.9	9.8
UK	11.2	20.6	31.8	Hong Kong	1.9	7.6	9.5
Hungry	1.3	29.6	30.9	Qatar	2.6	4.0	6.6
Jordan	30.5	0.0	30.5	Guatemala	6.0	0.4	6.4
Australia	13.3	16.0	29.3	Trinidad & Tobago	6.2	0.0	6.2
Italy	1.5	27.6	29.1	South Africa	2.1	3.0	5.1
Iran	23.0	3.4	26.4	Bulgaria	0.3	4.6	4.9
Iceland	26.0	0.0	26.0	Ukraine	1.4	1.1	2.5
Slovak Rep.	5.4	20.4	25.8	Malaysia	0.9	1.0	1.9
Saudi Arabia	9.3	16.4	25.7	Gerogia	1.8	0.0	1.8
Croatia	4.5	20.3	24.8	Moldova	0.6	0.0	0.6

Source: IRODaT (2008)

Table A2: The ABO and RdH blood type distribution of Iran provinces *

	ABO				RdH		
	O	A	B	AB	+	-	
Azarbayejan Gharbi	37.4%	20.9%	32.9%	8.8%	90.2%	9.8%	**1.62%**
Azarbayejan Sharghi	37.3%	20.9%	33.9%	7.9%	88.6%	11.4%	**7.08%**
Booshehr	27.2%	27.2%	40.1%	5.4%	92.5%	7.5%	**0.10%**
Chahar Mahal & Bakhtiari	32.1%	19.5%	43.9%	4.5%	88.8%	11.2%	**0.32%**
Fars	28.8%	24.9%	39.0%	7.2%	90.4%	9.6%	**2.02%**

Gilan	30.5%	22.1%	41.0%	6.4%	89.2%	10.8%	**4.90%**
Hamedan	32.9%	23.7%	35.8%	7.6%	91.0%	9.0%	**3.85%**
Hormozgan	19.9%	28.1%	46.2%	5.8%	91.8%	8.2%	**0.06%**
Ilam	37.3%	23.6%	32.3%	6.8%	91.6%	8.4%	**0.09%**
Isfahan	32.9%	22.9%	37.4%	6.9%	89.5%	10.5%	**4.77%**
Kermanshah	32.2%	23.8%	36.2%	7.8%	91.0%	9.0%	**1.72%**
Kerman	27.0%	28.5%	37.1%	7.4%	89.0%	11.0%	**1.15%**
Khoozestan	29.7%	24.9%	38.8%	6.6%	91.2%	8.8%	**2.44%**
Khorasan	29.9%	26.8%	35.0%	8.2%	89.5%	10.5%	**4.37%**
Kohkilooyeh & Boyer Ahmad	31.9%	13.3%	50.4%	4.4%	88.5%	11.5%	**0.04%**
Kurdestan	31.6%	24.6%	36.5%	7.3%	90.9%	9.1%	**0.75%**
Lorestan	34.1%	21.6%	37.6%	6.7%	91.9%	8.1%	**1.28%**
Markazi	31.8%	24.0%	36.9%	7.3%	89.2%	10.8%	**8.74%**
Mazandaran	29.0%	24.8%	39.2%	7.0%	90.1%	9.9%	**5.08%**
Semnan	30.6%	25.8%	34.5%	9.0%	89.4%	10.6%	**3.63%**
Sistan & Baloochestan	26.5%	28.7%	38.4%	6.4%	89.4%	10.6%	**0.19%**
Tehran	32.4%	23.5%	35.9%	8.2%	89.6%	10.4%	**43.29%**
Yazd	26.7%	32.4%	31.0%	9.9%	87.2%	12.8%	**1.33%**
Zanjan	34.0%	21.8%	35.9%	8.3%	90.2%	9.8%	**1.20%**
Iran	**32.1%**	**23.7%**	**36.4%**	**7.8%**	**89.6%**	**10.4%**	

* The data is arranged based on an older version of national divisions which currently is changed and consist of 30 provinces. Source: IBTO (2000)

Table A3: ABO allele frequencies in 21 Iranian population groups

	p (A)	q (B)	r (O)
Tehranis	22.74%	16.85%	60.41%
Gilanis	20.54%	15.43%	64.03%
Mazandaranis	20.02%	17.35%	62.63%
Azaris	25.06%	16.16%	58.78%
Kurds	22.48%	17.10%	60.42%
Lurs	22.05%	14.55%	63.40%
Khorasanis	20.61%	18.10%	61.29%
Isfahanis	21.91%	16.87%	61.22%
Farsis	19.76%	16.91%	63.33%
Yazdis	20.21%	24.20%	55.59%
Kermanis	21.48%	16.89%	61.63%
Baluchis	18.59%	19.15%	62.26%
Bandaris	15.70%	18.05%	66.25%
Khoozestanis	19.44%	17.17%	63.39%
Turkomans	21.12%	24.81%	54.07%
Ghashghaais	20.07%	14.30%	65.63%
Arabs	17.23%	22.34%	60.43%
Assyrians	37.06%	11.69%	51.25%
Armenians	37.78%	10.92%	51.30%
Zoroastrians	16.38%	29.94%	53.68%
Jews	26.63%	18.56%	54.81%
Total	**22.23%**	**16.95%**	**60.82%**

Source: Walter et al. (1991)

References

Abadie, A. & S. R. Gay (2006) "The Impact of Presumed Consent Legislation on Cadaveric Organ Donation: A Cross-Country Study", *Journal of Health Economics*, **25(4)**, pp 599-620.

Abdulkadiroglu, A. & T. Sönmez (1999) "House Allocation with Existing Tenants", *Journal of Economic Theory*, **88(2)**, pp 233-260.

BBC (2008) *'Six-way' kidney transplant first*, published on BBC news website on 9 April 2008; available online at: http://news.bbc.co.uk/1/hi/health/7338437.stm.

Becker, G. S. & J. J. Elıas (2007) "Introducing Incentives in the Market for Live and Cadaveric Organ Donations", *Journal of Economic Perspectives*, **21(3)**, pp 3-24.

Becker, G. S. (2006) *Should the Purchase and Sale of Organs for Transplant Surgery Be Permitted?*, published on his weblog on 1 January 2006; available online at: http://www.becker-posner-blog.com/.

Boseley, S. (2006) "UK transplant patients go to China for organs from executed prisoners", *The Guardian*, 20 April 2006.

Cohen, L. R. (1989) "Increasing the Supply of Transplant Organs: The Virtues of a Futures Market", *George Washington Law Review*, **58(1)**, pp 1-51.

Daar, A. S. (2006), "The Case for a Regulated System of Living Kidney Sales", *Nature Clinical Practice Nephrology*, **2(11)**, 600-601.

Danovitch, G. M. & A. B. Leichtman (2006) "Kidney Vending: The "Trojan Horse" of Organ Transplantation", *Clinical Journal of American Society of Nephrology*, **1(6)**, pp 1133-1135.

El-Agroudy, A. E., M. A. Bakr, N. A. Hassan, A. M. Ismail, B. Ali-El-Dein, A. B. Shehab El-Dein & M. A. Ghoneim (2003) "Characteristics of Long-Term Live-Donor Renal Allograft Survivors", *American Journal of Nephrology*, **23(3)**, pp 165-171.

El-Husseini, A. A., M. A. Foda, Y. M. Osman & M. A. Sobh (2006) "Characteristics of long-term live-donor pediatric renal transplant survivors: A single-center experience", *Pediatric Transplantation*, **10(3)**, pp 288-293.

Epstein, R. (1993) "Organ Transplants: Is Relying on Altruism Costing Lives?", *American Enterprise*, **4(6)**, pp 50-57.

Ghods, A. J. & S. Savaj (2006) "Iranian Model of Paid and Regulated Living-Unrelated Kidney Donation", *Clinical Journal of American Society of Nephrology*, **1(6)**, pp 1136-1145.

Gloor, J. & M. Stegall (2007) "ABO incompatible kidney transplantation", *Current Opinion in Nephrology & Hypertension*, **16(6)**, pp 529-534.

Goyal, M., R. L. Mehta, L. J. Schneiderman & A. R. Sehgal (2002) "Economic and Health Consequences of Selling a Kidney in India", *Journal of the American Medical Association*, **288(13)**, pp 1589-1593.

Grassmann, A., S. Gioberge, S. Moeller & G. Brown (2005) "ESRD Patients in 2004: Global Overview of Patient Numbers, treatment modalities and associated trends", *Nephrology Dialysis Transplantation*, **20(12)**, pp 2587-2593.

Griffin, A. (2007), "Kidneys on Demand: Did Iran Eliminate Its Waiting List for Kidney Transplants? And if so, Where are the Kidneys Coming from?", *British Medical Journal*, **334(7592)**, pp 502-505.

Harmon, W. & F. Delmonico (2006) "Payment for Kidneys: A Government-Regulated System Is Not Ethically Achievable?", *Clinical Journal of American Society of Nephrology*, **1(6)**, pp 1146-1147.

Hausman, J. A. & G. K. Leonard (2007) "Estimation of patent licensing value using a flexible demand specification", *Journal of Econometrics*, **139(2)**, pp 242–258.

IBTO: Iran Blood Transfusion Organisation (2002) *The Clinical Use of Blood*, IBTO Publications, Tehran, Iran. (In Persian)

IRODaT - International Registry of Organ Donation and Transplantation (2009) The On-line Database that Provides the Annual Information of the Donation and Transplantation Activity from Different Countries, Can be found On-line at: www.tpm.org.

Kaserman, D. L. & A. H. Barnett (2002) *The US Organ Procurement System: A Prescription for Reform*, The AEI Press, Washington DC, US.

Kram, D. (2001) "Illegal Human Organ Trade from Executed Prisoners in China", *TED Case Studies*, **11(2).**

Mahdavi-Mazdeh, M., A. Heidary-Rouchi, M. Aghighi & H. Rajolani (2008) "Organ and Tissue Transplantation in Iran", *Saudi Journal of Kidney Diseases and Transplantation*, **19(1)**, pp 127-131.

Makiyama, K., K. Tanabe, H. Ishida, T. Tokumoto, H. Shimmura, K. Omoto & H. Toma (2003) "Successful Renovascular Reconstruction for Renal Allografts with Multiple Renal Arteries", *Transplantation*, **75(6)**, pp 828-832.

Malakoutian, T., M. S. Hakemi, A. A. Nassiri, M. Rambod, A.Nobakht H., B. Broumand, & I. Fazel (2007) "Socioeconomic Status of Iranian Living Unrelated Kidney Donors: A Multicenter Study", *Transplantation Proceedings*, **39(4)**, pp 824–825.

Matas, A. J. (2006) "Why We Should Develop a Regulated System of Kidney Sales: A Call for Action!", *Clinical Journal of American Society of Nephrology*, **1(6)**, pp 1129-1132.

Matas, A. J., S. T. Bartlett, A. B. Leichtman, F. L. Delmonico (2003) "Morbidity and mortality after living kidney donation, 1999–2001: survey of United States transplant centers", *American Journal of Transplant*, **3**, pp 830-834.

Mellström, C. & M. Johannesson (2008) "Crowding Out in Blood Donation: Was Titmuss Right?", *Journal of The European Economic Association*, **6(4)**, pp 845-863.

NKUDIC: National Kidney and Urologic Diseases Information Clearinghouse (2007) *Kidney and Urologic Diseases; Statistics for the United States*, U.S. Department of Health and Human Services.

Nobakht H., A. & N. Ghahramani (2006), "Living Unrelated Kidney Donor Transplantation in Iran", *Nature Clinical Practice Nephrology*, **2(12)**, E1.

Nwankwo, E., A. K. Bello & A. M. El Nahas (2005) "Chronic kidney disease: Stemming the global tide", *American Journal of Kidney Diseases*, **45(1)**, pp 201-208.

Patel, T. (1996) “India Kidney Trade”, *TED Case Studies*, **5(1).**

Pondrom, S. (2008) “Is the Iranian Paid Donation Model a Success … or Not?”, *American Journal of Transplantation*, **8(3)**, pp 477-478.

Quigley, M. (2007) “Property and the body: Applying Honoré”, *Journal of Medical Ethics* **33(11)**, pp. 631-634.

Reese, P. P., A. L. Caplan, A. S. Kesselheim & R. D. Bloom (2006) “Creating a Medical, Ethical, and Legal Framework for Complex Living Kidney Donors”, *Clinical Journal of American Society of Nephrology*, **1(6)**, pp 1148-1153.

Roth, A. E. (2007) “Repugnance as a Constraint on Markets”, *Journal of Economic Perspectives*, **21(3)**, pp 37–58

Roth, A. E., T. Sönmez, & M. U. Ünver (2004) “Kidney Exchange”, *Quarterly Journal of Economics*, **119(2)**, pp 457-488.

Roth, A. E., T. Sönmez, & M. U. Ünver (2005a) “A Kidney Exchange Clearinghouse in New England”, *American Economic Review (Papers and Proceedings)*, **95(2)**, pp 376-380.

Roth, A. E., T. Sönmez, & M. U. Ünver (2005b) ”Pairwise Kidney Exchange” *Journal of Economic Theory*, **125(2)**, pp 151-188.

Roth, A. E., T. Sönmez, & M. U. Ünver (2007) “Efficient Kidney Exchange: Coincidence of Wants in Markets with Compatibility-Based Preferences”, *American Economic Review*, **97(3)**, pp 828-851.

Saidman, S. L., A. E. Roth, T. Sönmez, M. U. Ünver, & F. L. Delmonico (2006) “Increasing the Opportunity of Live Kidney Donation By Matching for Two and Three Way Exchanges", *Transplantation*, **81(5)**, pp 773-782.

SCI: Statistical Centre of Iran (2007) *The outcomes of the Iranian National Census 2006*, Tehran, Iran.

Stein, R. (2007) “New Zeal in Organ Procurement Raises Fear”, *Washington Post*, 13 September 2007.

Titmuss, R. (1997) *The Gift Relationship: from Human Blood to Social Policy*, Originally published in 1970 as: *The Gift Relationship*, Allen & Unwin, London; New chapters added; Eds A. Oakley & J. Aston, LSE Books, London, UK.

UK Transplant (2007) *UK Transplant Fact Sheet 4: the Cost-Effectiveness of Transplantation*, UK Transplant, NHS, Available online at: http://www.uktransplant.org.uk/ukt/newsroom/fact_sheets/cost_effectiveness_of_transplantation.jsp

Walter, H., D. D. Farhud, H. Danker-Hopfe & P. Amirshahi (1991) “Investigation on the Ethnic Variability of the ABO Blood Group Polymorphism in Iran”, *Zeitschrift fur Morphologie und Anthropologie*, **78(3)**, pp 289-306.

Wintour, P. (2008) “Brown backs opt-out system to boost organ transplants”, *The Guardian*, 14 January 2008.

Xue, J. L., J. Z. Ma, T. A. Louis & A. J. Collins (2001) “Forecast of the Number of Patients with End-Stage Renal Disease in the United States to the Year 2010”, *Journal of American Society of Nephrology*, **12(12)**, pp 2753-2758.

Zargooshi, J. (2001) “Quality of Life of Iranian Kidney “Donors””, *Journal of Urology*, **166(5)**, pp 1790-1799.