

# The impact of presumed consent legislation on cadaveric organ donation: A cross-country study

Alberto Abadie<sup>a,\*</sup>, Sebastien Gay<sup>b</sup>

<sup>a</sup> *Harvard University, John F. Kennedy School of Government, 79 JFK Street, Cambridge, MA 02138, United States*

<sup>b</sup> *Department of Economics, University of Chicago, 1126 E. 59th Street, Chicago, IL 60637, United States*

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## Abstract

In the U.S., Great Britain and in many other countries, the gap between the demand and the supply of human organs for transplantation is on the rise, despite the efforts of governments and health agencies to promote donor registration. In some countries of continental Europe, however, cadaveric organ procurement is based on the principle of presumed consent. Under presumed consent legislation, a deceased individual is classified as a potential donor in absence of explicit opposition to donation before death. This article analyzes the impact of presumed consent laws on donation rates. For this purpose, we construct a dataset on organ donation rates and potential factors affecting organ donation for 22 countries over a 10-year period. We find that while differences in other determinants of organ donation explain much of the variation in donation rates, after controlling for those determinants presumed consent legislation has a positive and sizeable effect on organ donation rates. We use the panel structure of our dataset to test and reject the hypothesis that unmeasured determinants of organ donation rates confound our empirical results.

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## 1. Introduction

Chronic shortage of human organs for transplantation is one of the most pressing health policy issues in many developed countries, including the U.S. and Great Britain. In recent years, the persistent scarcity of organs for transplantation has invigorated the controversy about the determi-

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\* Corresponding author. Tel.: +1 617 496 4547.

*E-mail addresses:* [alberto.abadie@harvard.edu](mailto:alberto.abadie@harvard.edu) (A. Abadie), [sgay@uchicago.edu](mailto:sgay@uchicago.edu) (S. Gay).

nants of organ donation rates and the magnitude of their effects. With a few exceptions, however, this debate has not been informed by systematic empirical studies.<sup>1</sup>

A particularly heated debate has arisen on the matter of legislative defaults on cadaveric organ donation. In many countries, including the U.S., Great Britain, Germany and Australia, cadaveric organ procurement is carried out under the informed consent principle. Under an informed consent law, cadaveric organ extraction requires the explicit consent of the donor before death, which is usually reflected on a donor registration card. In contrast, in most of continental Europe, cadaveric organ procurement is based on the principle of presumed consent. Under presumed consent legislation, a deceased individual is classified as a potential donor in absence of explicit opposition to donation before death. 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 are allowed to have the last word on whether organs will be donated. It has been argued, however, that legislative defaults affect the decisions of potential donors and families.<sup>2</sup>

This article uses a panel of 22 countries over a 10-year period to analyze the impact of presumed consent laws on donation rates. After controlling for other determinants of cadaveric organ donation, we find that countries with presumed consent legislation have higher organ donation rates. Moreover, we use the panel structure of our database to test and reject the hypothesis that unmeasured (additive) determinants of organ donation rates confound our empirical results.

The rest of the article is organized as follows. Section 2 summarizes the main facts highlighted in the previous literature on organ donation. Section 3 presents a simple model that illustrates a way in which legislative defaults may affect organ donation rates. The main empirical results of the article are given in Section 4. Section 5 concludes. Data sources and technical details are reported in [Appendices A–C](#).

## 2. The organ shortage problem

In 2002, 6679 patients died on the U.S. organ waiting lists before an organ became available, roughly 18 per day (OPTN, 2003). In spite of media campaigns and other attempts to promote donation, the supply of organs cannot keep up with the demand, and the number of patients on waiting lists has been growing steadily during the last decade (see [Fig. 1](#)). One of the most frequently quoted explanations of the gap between the supply and demand of organs is that the number of families that refuse to grant consent to donation is still large. Approximately half of the families that are approached to request donation refuse it in the U.S. and Great Britain, compared to around 20% in Spain and around 30% in France.<sup>3</sup> The U.S. and Great Britain are informed consent countries; Spain and France are presumed consent countries.

From an economist's point of view, the shortage of cadaveric organs for transplantation is an intriguing phenomenon. First, from a purely utilitarian perspective, it represents the routine disposal of a highly valuable commodity, with the potential to save lives. Moreover, survey data indicate a significant disagreement between preferences for donation and donor card registration. In particular, results from a well-known survey ([Gallup, 1993](#)) indicate that while most Americans

<sup>1</sup> Notable exceptions are [Gimbel et al. \(2003\)](#) and [Johnson and Goldstein \(2003\)](#).

<sup>2</sup> See [Sunstein and Thaler \(2003\)](#).

<sup>3</sup> The figure for the U.S. comes from [Nathan et al. \(2003\)](#) where it is taken from a variety of sources. For Great Britain, this information appears in [Barber et al. \(2003\)](#), it refers to the period of April 2003–June 2003, and it was conveyed to us in personal communication by Phil Pocock from UK Transplant. For Spain, we obtained the figure from [ONT \(2003\)](#) for the year 2002. Finally, for France, the figure comes from [EFG \(2003\)](#); it refers to the year 2002 and to potential donors deceased from encephalic death.

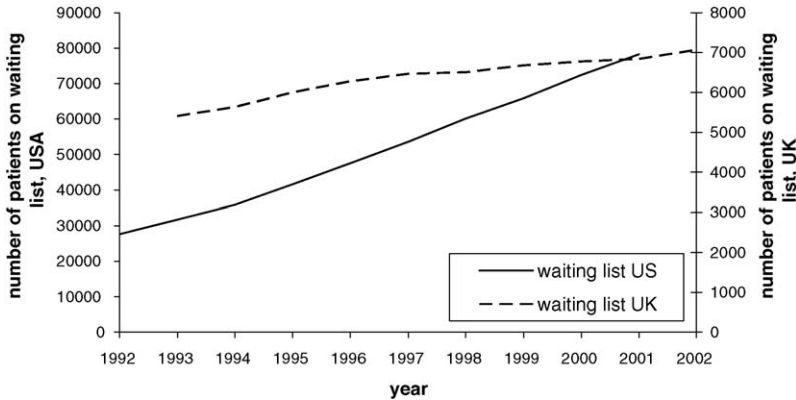


Fig. 1. Number of patients waiting for organs, U.S. and UK.

favor organ donation (85%), and would like to donate their organs after death (69%), only a few grant permission for organ extraction on their driver's license or an organ donor card (28%). Finally, in recent years the question of how defaults influence economic choices has become an issue of great interest among economists.<sup>4</sup>

The severe shortage of human organs for transplantation in the U.S. has prompted numerous proposals to alleviate this problem. In addition to presumed consent legislation, proposals include financial incentives for donors (Kaserman and Barnett, 2002; Becker and Elias, 2003), xenotransplantation (transplantation of organs from a different species, usually pigs), educational campaigns, organ exchange mechanisms for living donors with incompatible recipients (Roth et al., 2004), and preferential assignment of organs to registered donors.<sup>5</sup>

However, increasing donation consent rates from families is still viewed as the most promising route to increase organ donation (UNOS, 2002). Many analysts and health professionals believe that presumed consent legislation may play an important role in shaping the decision of the families. In an international survey of transplant professionals, 75% of the respondents supported presumed consent legislation, and 39% identified this type of legislation as the most effective measure to increase donation rates, the highest percentage among all measures considered in the survey, followed by improved education with 18% (Oz et al., 2003).

Several factors other than legislative defaults have been hypothesized to affect cadaveric donation rates in the medical literature. These factors include the level of wealth, religious beliefs and social norms, education and medical infrastructure. In addition, most deceased donors are patients who have suffered irreversible brain injury resulting in brain-death, but whose heartbeats are maintained through artificial ventilation. The most common causes of death of these patients are traffic accidents and cerebro-vascular diseases. Consequently, the mortality rates for these two causes of death have been considered important determinants of organ donation rates.<sup>6</sup>

In this article, we analyze the impact of presumed consent legislation on cadaveric organ donation, after controlling for other factors that affect organ donation rates. An important consideration

<sup>4</sup> In a very influential study, Madrian and Shea (2001) found that for workers at a certain large U.S. corporation the participation rate in the firm's 401(k) retirement plan was higher under default enrollment and many of the workers retained the default contribution rate and fund allocation. On the impact of defaults on economic behavior, see also Samuelson and Zeckhauser (1988), Choi et al. (2003) and Thaler and Sunstein (2003).

<sup>5</sup> See Oz et al. (2003). In addition, Votruba (2001) has studied the efficient allocation of cadaveric organs.

<sup>6</sup> See Cameron and Forsythe (2001) for a further discussion of the factors which determine organ donation rates.

regarding the analysis conducted here is that the content and enforcement of presumed consent laws vary greatly across countries. In Austria, for example, a fairly strong version of presumed consent principle is applied, although family views may be taken into account. In Spain, as in most presumed consent countries, even when organ removal can be carried-out by law without the consent of the family, organ coordinators in charge of the donation process do not authorize the extraction of organs without an explicit family approval.

Because registration is nominally free (in all countries to our knowledge) and because families are usually allowed to make the final decision on whether or not organs will be donated, it is not obvious that legislative defaults on cadaveric organ donation should have an effect on donation rates. In the next section, we outline a simple model of donor registration and family consent that can sustain equilibria with higher donation rates in presumed consent countries than in informed consent countries.

### 3. A simple model of presumed consent

In this section, we outline a model of organ donation. Albeit simple, the model has two important implications: (1) even if families make the final decision on organ donation, presumed consent laws may result in notably higher consent and donation rates; (2) registration rates may be low even if registration costs are low (and even if preferences for donation are high in informed consent countries and low in presumed consent countries).

Let  $u_D$  and  $u_N$  be the utility levels realized in the donation and non-donation states, respectively. We allow  $u_D$  and  $u_N$  to vary across individuals. Let  $v = u_D - u_N$  be the utility gain derived from donation. Individuals observe their own  $v$ 's. Families, however, have imperfect information about the value of  $v$  for family members. The information of families about  $v$  is given by the mean-preserving spread  $z = v + \varepsilon$ , where  $\varepsilon$  is independent of  $v$  and has a log-concave density.<sup>7</sup> The distributions of  $v$  and  $\varepsilon$  are common knowledge. Individuals pay “contemplation costs” equal to  $c$  for registering as donors (in informed consent countries) or non-donors (in presumed consent countries). For simplicity, we assume  $c$  to be fixed and known to everybody. Arguably, it would be more appropriate to refer to  $c$  as “registration costs” rather than “contemplation costs”. However, we adopt the term “contemplation costs” in accordance with the medical literature, where the discrepancy between donation preferences and donor registration is habitually attributed to the perception that donor registration is often avoided because it forces potential donors to confront the prospect of their own death (see, e.g., *AMA, 1994*).<sup>8,9</sup>

In this model, registration can be regarded as a costly signaling device of donation preferences from the individual to the family. Instead of (or in addition to) signing a donor card, some indi-

<sup>7</sup> Log-concavity is a non-parametric regularity condition often used in information economics. Log-concavity is satisfied by most common distributions, such as the normal, uniform, logistic and Laplace distributions. See *An (1998)* for additional information on log-concavity.

<sup>8</sup> In practice, presumed consent and informed consent systems may induce different contemplation costs. For example, in an informed consent system, contemplation costs may include the disutility of confronting the prospect of organ extraction in addition to the disutility of confronting the prospect of death. Moreover, contemplation costs may be higher in an informed consent system if the public believe that doctors will not make every possible attempt to save the lives of registered donors (we are grateful to an anonymous referee for suggesting this example). For expositional simplicity, we establish our notation in a way that contemplation costs are the same in both systems. However, because the presumed consent and informed consent cases are analyzed separately in the model below, the results are general and do not depend on the contemplation cost being symmetric.

<sup>9</sup> As pointed out by a referee, certain policy interventions targeted to reduce registration costs (for example, allowing individuals to register over the Internet) may also have a sizeable impact on registration and organ donation rates.

viduals may communicate their preferences regarding organ donation directly to their relatives before death. However, survey data have detected a widespread reluctance to discuss organ donation issues with family members (see, for example, Gallup, 1993). Given that organ donor cards lack legal status and/or are not enforced in most countries, we conjecture that the role that organ donor cards may play in practice is to provide a channel to signal donation preferences to family members and organ procurement agencies, that does not require engaging in an active discussion with family members about death and organ donation preferences. See also Byrne and Thompson (2001) on the use of registration as a signal.<sup>10</sup>

Our model can be represented as an extensive form game. First, individuals decide whether or not to register after observing  $v$  and the type of legislation. Then, families decide whether or not to consent to donation, after observing the type of legislation, the registration decision of the individuals, and the value of  $z$ . Both potential donors and families choose their actions in order to maximize the expected utility of potential donors. Given the type of legislation, a pair of strategies in this game consists of two functions: the first function maps  $v$  on the registration decision of potential donors; the second function maps  $z$  and the registration decision of potential donors on the donation consent decisions of the families.

*Equilibrium in an informed consent country:* Consider a solution in which individuals register as donors if  $v \in V_1$ ; with  $v > 0$  for all  $v \in V_1$ . Families do not override the decision of deceased potential donors because, conditional on registration,  $v > 0$ .<sup>11</sup> For deceased potential donors who did not register, families evaluate  $E[v|v \notin V_1, v + \varepsilon = z]$ . Log-concavity of  $\varepsilon$  and independence between  $v$  and  $\varepsilon$  guarantee that  $v$  and  $z$  are affiliated random variables.<sup>12</sup> By the properties of affiliated random variables  $E[v|v \notin V_1, v + \varepsilon = z]$  is a non-decreasing function of  $z$ . Therefore, there exists some  $z_1$  such that families of deceased individuals who did not register donors refuse consent to organ extraction if  $z \leq z_1$ . For simplicity of the exposition, we will assume that  $z_1$  is an interior point in the support of  $z$ .

Consequently, the expected utility of a non-registered potential donor in an informed consent country is  $u_N Pr(z \leq z_1|v) + u_D Pr(z > z_1|v)$ . The expected utility of a registered donor in an informed consent country is  $u_D - c$ . Therefore, an individual becomes a registered donor if  $v Pr(z \leq z_1|v) > c$ , which is consistent with the assumption that all the elements of  $V_1$  are positive. Notice that registered donors are a subset of those individuals with  $v > c$ .

An equilibrium is characterized in this model by

$$V_1 = \{v : v Pr(z \leq z_1|v) > c\},$$

for the registration decision of the individuals, and

$$E[v|v Pr(z \leq z_1|v) < c, v + \varepsilon = z_1] = 0,$$

for the donation consent decision of the families.<sup>13</sup>

<sup>10</sup> In the words of Byrne and Thompson (2001): "When organ procurement organizations defer to the wishes of surviving family members, donor registration is nothing more than a signaling device which may be helpful in a society in which issues related to death are rarely discussed."

<sup>11</sup> In reality, families' own views on organ donation may sometimes influence consent decisions. However, it has been documented that families who know that their relatives wished to donate their organs after death overwhelmingly consent to donation (see Siminoff et al., 2001; OPTN/SRTR, 2003.)

<sup>12</sup> See Appendix A for the proof, and Krishna (2002) for more on affiliated random variables.

<sup>13</sup> The concept of equilibrium is Perfect Bayesian Equilibrium. For simplicity, assume that  $\varepsilon$  has full support on the real line. Then, every information set is on the equilibrium path, and Bayes' Rule applies everywhere. Families update their beliefs using Bayes' Rule, and the actions of potential donors are optimal given families' strategies.

*Equilibrium in a presumed consent country:* Under a presumed consent default the analysis is analogous. Consider a solution in which individuals register as non-donors if  $v \in V_P$ , with  $v < 0$  for all  $v \in V_P$ . Families do not override the decision of deceased potential donors because, conditional on registration,  $v < 0$ . For deceased potential donors who did not register, families evaluate  $E[v|v \notin V_P, v + \varepsilon = z]$ . Because this expectation is a monotonic function of  $z$ , there exists some  $z_P$  such that families of deceased individuals who did not registered as non-donor consent to organ extraction if  $z \geq z_P$ . We will consider the case in which  $z_P$  is an interior point in the support of  $z$ .

Using the same analysis as for the informed consent case, it is easy to show that an individual will register as a non-donor if  $vPr(z \geq z_P|v) < -c$ , which is consistent with the assumption that all the elements of  $V_P$  are negative. Notice that registered non-donors are a subset of those individuals with  $v < -c$ .

A solution to this problem is given by

$$V_P = \{v : vPr(z \geq z_P|v) < -c\},$$

for the registration decision of the individuals, and

$$E[v|vPr(z \geq z_P|v) > -c, v + \varepsilon = z_P] = 0,$$

for the donation consent decision of the families.

*Implications of the model:* It can be shown that if the density of  $\varepsilon$  is log-concave, then, for any given  $z_1$  and  $z_P$ , the sets  $V_1$  and  $V_P$  are either intervals or empty sets.<sup>14</sup> Fig. 2 shows an example of equilibrium strategies for the case when  $V_1$  and  $V_P$  are non-empty intervals in equilibrium. In an informed consent country, individuals register as donors if  $v \in V_1$ , and families consent to donation if either the deceased potential donor registered or if  $z > z_1$ . In a presumed consent country, individuals register as non-donors if  $v \in V_P$ , and families consent to donation if the deceased potential donor did not register and  $z \geq z_P$ .

Consider first the implications of the model under informed consent legislation. Because registration generates a contemplation cost,  $c > 0$ , and because families have some information about  $v$ , not all individuals with  $v > 0$  register as donors. Individuals with positive but low  $v$  do not register because the contemplation cost is high relative to the utility derived from donation. Moreover, individuals with positive but low  $v$  may not register even if  $v > c$ , provided that the probability that  $z > z_1$  is large enough. Individuals with high  $v$  may not register either, because the probability that for them  $z \leq z_1$  is very small. Only individuals with intermediate positive values of  $v$ , those with  $v \in V_1$ , will register.<sup>15,16</sup> In absence of registration costs, however, all the individuals with  $v > 0$  would register as donors. The combination of registration costs and the fact that families have additional information about the preferences for donation of family members reduces registration rates in informed consent countries. The same conclusion holds also for presumed consent countries.

A second important implication of the model is that legislative defaults on cadaveric organ donations may influence family consent rates for non-registered potential donors. Consider the

<sup>14</sup> See Appendix A for the proof.

<sup>15</sup> In this sense, the model outlined in this section is related to some recent developments regarding non-monotonic strategies in signaling models. See, e.g., Feltovich et al. (2002).

<sup>16</sup> If the support of  $v$  is bounded, all individuals with strong preferences for donation may register in equilibrium. That would be the case also if individuals with strong preferences for donation derived a sufficiently large consumption value from registration or if they incurred sufficiently lower contemplation costs. For simplicity and because the substantive implications of the model are identical, we do not follow these potential extensions here.

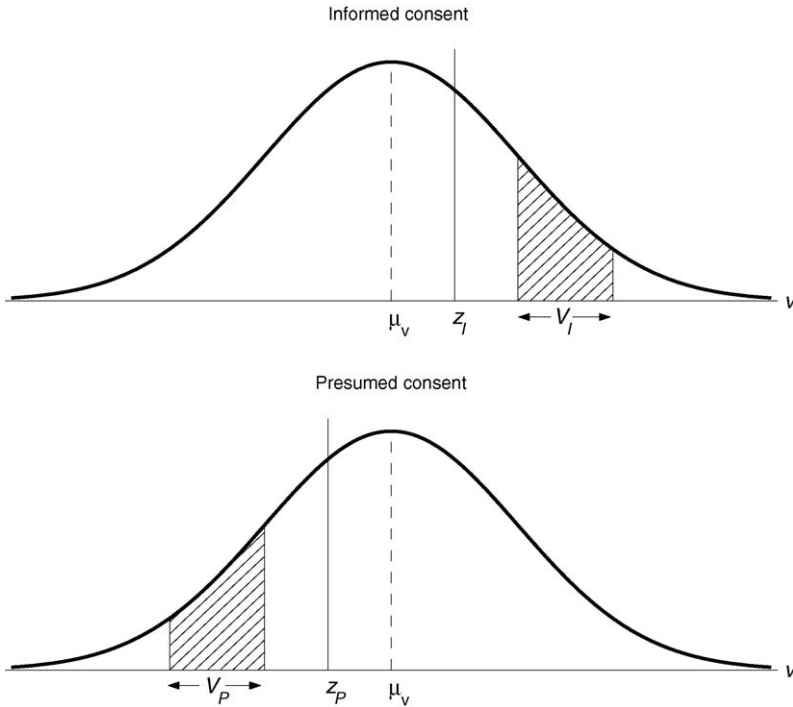


Fig. 2. Registration and consent decisions in the model.

setting in which both  $\varepsilon$  and  $v$  are symmetrically distributed with respect to zero. Then, it is easy to prove that  $z_P = -z_I$  and  $V_P = -V_I$ . Using the fact that  $z$  and  $v$  are affiliated, it can be easily seen that  $Pr(z \geq z_P | v \notin V_P) \geq Pr(z \geq z_I | v \notin V_I)$ .

That is, under presumed consent, family consent rates for non-registered individuals are equal to or larger than under informed consent. At an intuitive level, informed consent laws allow individuals with strong preferences for donation to separate. As a result, families in informed consent countries infer that non-registered individuals had weak preferences for donation on average, and do not consent unless the indicator  $z$  is large. In contrast, in presumed consent countries, individuals with strong aversion to donation are allowed to separate. Families in presumed consent countries infer that non-registered individuals had strong preferences for donation on average, and consent to donation unless the indicator  $z$  is small.<sup>17</sup>

Higher family consent rates for non-registered potential donors in conjunction with low registration rates tend to generate equilibria in which presumed consent legislation produces higher donation rates than informed consent legislation. To see this, consider the following numerical example. Let  $v$  and  $\varepsilon$  be distributed as normal independent variables with mean equal to 0 and variance equal to 1. Let  $c$ , the registration cost, be equal to .25. It is easy to show that, for these values of the parameters,  $z_I = .4222$  and  $V_I = [.5631, 1.2815]$  define a pair of equilibrium strategies under informed consent legislation. Similarly,  $z_P = -.4222$  and  $V_P = [-1.2815, -.5631]$  define a

<sup>17</sup> In reality of course, individuals are always able to separate by communicating preferences for donation directly to their families. However, if the cost of discussing organ donation with family members is high relative to registration costs, then the qualitative predictions of the model still apply.

pair of equilibrium strategies under presumed consent legislation.<sup>18</sup> For this example, registration rates are around 18% under either presumed or informed legislation, even when around 40% of the individuals have  $v > c$  (or  $v < -c$ ). In addition, the 18% registration rate is much lower than the 50% rate that would arise if the model did not incorporate a registration cost. These equilibria generate donation rates of around 44% under informed consent legislation and around 56% under presumed consent legislation, with a difference of around 12 percentage points.

The model described in this section shows that, as a result of a signal-extraction problem, presumed consent defaults may generate higher donation rates than informed consent defaults. However, the model is not unambiguous in this conclusion: it is possible to find examples in which presumed consent laws have zero or negative effects on donation rates.<sup>19</sup> Moreover, signal-extraction is not the only channel through which legislative defaults may affect organ donation.<sup>20</sup> Ultimately, whether or not presumed consent laws have an effect on donation rates is an empirical issue. In the next section, we use data on organ donation rates, legislative defaults on cadaveric organ donation, as well as other factors affecting cadaveric organ donation, for a panel of countries to investigate the effect of presumed consent legislation on organ donation rates.

#### 4. Empirical analysis

Despite the worldwide concern about organ shortage for transplantation, few empirical studies have aimed to identify and measure the factors that influence donation rates. The reason may be, in part, that the data required to conduct these studies are not readily available.<sup>21</sup> This is particularly true concerning information on legislative defaults on organ donation for different countries.

For the empirical analysis in this section, we collected information on legislative defaults for a sample of 36 countries. Fig. 3 shows donation rates (per million population) and type of legislation in 2002 for the 36 countries in our sample. Presumed consent countries seem to have higher donation rates than informed consent countries. However, the connection between legislative defaults and donation rates is not completely unequivocal. Fig. 3 also shows that one country, Spain, has higher donation rates than any other country. This fact is well-documented in the medical literature, where the “Spanish model” of organ procurement has been studied extensively.<sup>22</sup>

<sup>18</sup> See Appendix A for the solution of the model under normality.

<sup>19</sup> For example, if most individuals have strong preferences for organ donation and families observe an uninformative indicator of donation preferences, a presumed consent law may create a separating equilibrium in which the few individuals with strong aversion for donation register and do not donate. In the same scenario, an informed consent law may create a pooling equilibrium, in which individuals with strong aversion to donation are not able to separate.

<sup>20</sup> Data from laboratory experiments and observational studies have provided evidence of the existence of a preference to maintain the status-quo that influences individual decision making (see, for example, Samuelson and Zeckhauser, 1988). If a preference to comply with the status-quo exists in the context of organ donation, that by itself will create a direct link between legislative defaults on organ donations and organ donation rates. Moreover, some authors have suggested that presumed consent laws may affect the consent decisions of the families because they change the framing of the request of consent to the families, by creating a strong expectation that consent will be granted (see, for example, Cameron and Forsythe, 2001).

<sup>21</sup> As Cameron and Forsythe (2001) put it: “. . . the quantity of hard data on donation remains small, and what is available is often not readily accessible. Neither has all the information been assembled in one place and correlated . . .”.

<sup>22</sup> The Spanish national transplant organization (ONT) is considered the most effective organ procurement organization in the world. Several countries, including Australia and the UK have considered adopting the Spanish organ procurement system, often referred to as the “Spanish model”. The “Spanish model” is based on: (i) a system of independent transplant coordination teams, which request consent from families of potential donors so the burden of organ procurement is taken away from transplant surgeons and treating physicians; (ii) a hospital reimbursement policy, which compensates



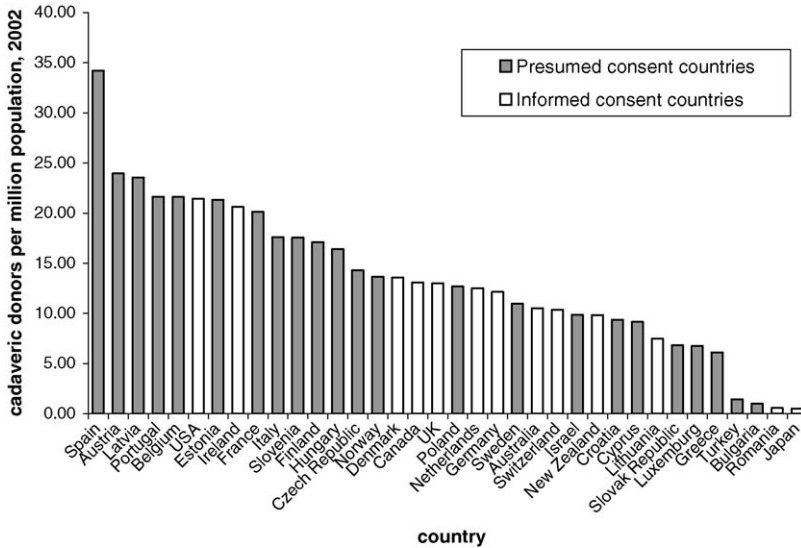


Fig. 3. Cadaveric donation rates in 2002.

For 22 countries in our sample and the period 1993–2002 we obtained information on a number of factors that are thought to affect donation rates and legislative defaults on organ donation, such as per capita GDP, health expenditures per capita, religious beliefs, the legislative system and the number of deaths caused by motor vehicle accidents and cerebro-vascular diseases. We assembled our dataset using a variety of sources, which are detailed in [Appendix B](#).<sup>23</sup>

In this section, we use regression analysis to study how presumed consent legislation is related to cadaveric organ donation rates, after controlling for other determinants of organ donation.

[Table 1](#) shows descriptive statistics for the sample of countries used for our regression analysis. Column (1) shows means and standard deviations for the entire sample. Fifty-six percent of the observations in our sample are for presumed consent countries. Columns (2) and (3) show means and standard deviations for presumed consent and informed consent countries, respectively. The last column contains the differences between columns (2) and (3), along with *t*-statistics for the null hypothesis of equality of means for presumed and informed consent countries.

It has been pointed out in the medical literature that donation rates are not markedly higher in presumed consent countries (see, e.g., [Cameron and Forsythe, 2001](#)). [Table 1](#) shows that in our sample, informed consent countries have on average 14.19 cadaveric donors per million population per year. Presumed consent countries have on average 17.29 cadaveric donors per million population per year, 3.10 more than informed consent countries. This difference, however, is not significant at conventional test levels. In addition, relative to informed consent countries, presumed consent countries have lower GDP per capita, and lower health expenditures per capita, although again none of these differences is significant at conventional levels. Presumed consent

hospitals for organ procurement costs; and (iii) a multi-layered network at the national, regional, and hospital level, which coordinates and manages organ procurement activities. See [Matesanz \(2001\)](#) for details.

<sup>23</sup> To reduce heterogeneity in social norms, we restricted our sample to Western Christian countries (Catholic or Protestant). [Appendix B](#) describes our sample selection criteria in detail. [Appendix C](#) contains information on legislative defaults on organ donation rates for the 36 countries considered in [Fig. 3](#).

Table 1  
Descriptive statistics (means and standard deviations)

	Entire sample (1)	Presumed consent countries (2)	Informed consent countries (3)	Difference (S.E.) (2) – (3)
Presumed consent country	.5634 [.4971]			
Cadaveric donors (per million population)	15.94 [5.35]	17.29 [6.01]	14.19 [3.72]	3.10 (1.99)
GDP per capita (constant 1995 USD)	22366 [9768]	19879 [11241]	25576 [6161]	–5,697 (3731)
Health expenditures per capita (constant 1995 USD)	1930 [970]	1634 [946]	2285 [880]	–651 (399)
Catholic country	.4413 [.4977]	.7000 [.4602]	.1075 [.3114]	.5925** (.1663)
Common law	.2817 [.4509]	0 [0]	.6452 [.4811]	–.6452** (.1576)
MVA and CVD deaths (per thousand population)	1.2123 [.4374]	1.4156 [.4570]	.9518 [.2217]	.4638** (.1523)
Number of countries	22	13	10	
Number of observations	213	120	93	

Notes: Standard deviations in brackets. Standard errors in parentheses are clustered by country. The number of countries with informed and presumed consent laws do not sum to the total number of countries in the sample because one of the countries in the sample (Sweden) changed legislation during the sample period.

\*\* Indicates statistical significance at the 5% level.

countries are predominantly Catholic, while informed consent laws are the rule in countries with a legislative system based on common law. Finally, the combined mortality rate in motor vehicle accidents (MVA) and cerebro-vascular diseases (CVD) is significantly higher in presumed consent countries.

Table 2 reports estimated coefficients for the regression of the log of cadaveric donation rates on an indicator of a presumed consent legislative default and other predictors of donation rates.<sup>24</sup> Column (1) shows that, on average, donation rates are roughly 16% higher in presumed consent countries. However, this difference is not significant at conventional test levels. Some analysts have argued that the positive difference in donation rates between presumed and informed consent countries may be due to the outlier effect of Spain, which maintains presumed consent legislation. In column (2) we repeat the regression from column (1), this time excluding Spain from our sample. As expected, the estimated coefficient on the presumed consent legislation indicator decreases relative to column (2) and remains statistically indistinguishable from zero at conventional test levels. Thus, our data are consistent with the view in the medical literature that donation rates in presumed consent countries are not much higher on average, relative to informed consent countries.

However, as shown in Table 1, the distributions of some potential determinants of donation rates differ between presumed and informed consent countries. In columns (3)–(8) of Table 2, we include in the regression the other determinants of organ donation considered in Table 1. In columns (3) and (4) we include measures of wealth and medical expenditures.<sup>25</sup> In both cases, the coefficient on the presumed consent variable indicates roughly 26% higher donation rates in

<sup>24</sup> Standard errors are clustered at the country level. All specifications include year fixed-effects.

<sup>25</sup> The two variables are highly collinear, with health expenditures representing a roughly constant 9–10% fraction of GDP.

Table 2  
The effect of presumed consent legislation on cadaveric organ donation (pooled OLS, 1993–2002)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<b>Legislation</b>								
Presumed consent	.1559 (.1352)	.1027 (.1316)	.2615** (.1206)	.2577** (.1233)	.2839** (.1294)	.2562* (.1386)	.3111** (.1238)	.2493** (.1164)
<b>Wealth and health expenditures</b>								
Log GDP per capita			.2191* (.1205)		.2561* (.1374)	.3138** (.1448)	.3032** (.1309)	.3145** (.1181)
Log of health expenditures per capita				.2061* (.1175)				
<b>Religious beliefs</b>								
Catholic country					.1705 (.1717)	.0913 (.1846)		
<b>Legislative system</b>								
Common law					.1636 (.1084)	.3109* (.1609)	.3233* (.1668)	.3460** (.1643)
<b>Potential donors</b>								
Log of MVA and CVD deaths (per 1000 population)						.4090* (.2282)	.4104* (.2244)	.4863** (.1938)
Include Spain	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Specification test ( <i>p</i> -value)			.9504	.3876	.9074	.2230	.2340	.3863
<i>R</i> -squared	.0587	.0342	.2111	.2124	.2754	.3216	.3111	.3636
Number of observations	213	203	213	186	213	146	146	140

*Notes:* The dependent variable is the natural logarithm of cadaveric donation rates, per million population per year. Standard errors (in parentheses) are robust to arbitrary heteroskedasticity and autocorrelation within country. All specifications include year fixed-effects. The table reports *p*-values for the null hypothesis of absence of correlated fixed effects.

\* Indicates statistical significance at the 10% level.

\*\* Indicates statistical significance at the 5% level.

presumed consent countries. This difference is significant at conventional test levels. In columns (5)–(8), we report the results for regression models that include additional variables that measure potentially relevant country characteristics: religious beliefs, whether the country has a common law or a civil law system, and the number of deaths caused by motor vehicle accidents and cerebro-vascular diseases. In all cases, including these variables in the regression does not change substantially the value of the coefficient on the presumed consent indicator. This is true even though, as shown in column (6), the variables considered in our regression models explain almost one-third of the variance of the dependent variable ( $R^2 = .3216$ ). In column (8), we show that when other determinants of cadaveric donation rates are accounted for, the coefficient on the presumed consent variable is still large and significant even if we exclude Spain from the sample.

On the whole, the results of [Table 2](#) show that, when other determinants of donation rates are accounted for, presumed consent countries have roughly 25–30% higher donation rates than informed consent countries on average. Moreover, this result is robust to changes in the regression specification.<sup>26,27</sup>

A potential concern about the analysis in this section is that our results will be biased if unobserved determinants of cadaveric organ donation rates are correlated with the passage of presumed consent laws. In particular, it could be argued that countries where the population have a strong preference for organ donation would be inclined to enact presumed consent laws. In that situation, social preferences towards organ donation would induce a positive association between presumed consent laws and organ donation rates, and the coefficient on presumed consent in our regressions would be biased upwards. Fixed effects estimators for panel data are often used to control for time-invariant (additive) confounders. In our sample, legislative defaults on cadaveric organ donation rarely change over time. Therefore, we cannot include country fixed effects in our regression specifications and still identify the coefficient on the presumed consent variable.<sup>28</sup> However, the absence of time-invariant confounders can be tested in regressions (3)–(8) of [Table 2](#), because these regressions include time-varying variables whose coefficients are identified in a specification with country fixed effects. If country effects are correlated with the presence of presumed consent laws, the coefficients on all the variables in our regressions will be biased in the pooled OLS specification, but not in the fixed-effects specification. We use the difference in the coefficients

<sup>26</sup> In addition to the results reported in [Table 2](#), we carried out a specification analysis in which we considered additional variables measuring education (e.g., average years of schooling of adults) and medical infrastructure (e.g., number of hospitals beds per capita). In all cases, the coefficients on the added variables were not statistically significant and their inclusion left the presumed consent coefficient virtually unchanged. To check that functional form assumptions on GDP per capita do not drive our results we re-estimated our regression models including up to a sixth order polynomial in GDP per capita instead of the log of GDP per capita. The results were nearly identical.

<sup>27</sup> As shown in [Table 1](#), presumed consent countries tend to have lower per capita incomes than informed consent countries. Moreover, the four countries in our sample with lowest per capita incomes, Poland, Czech Republic, Hungary, and Slovenia, are also the four former communist eastern European countries in the sample, all of which maintain presumed consent legislation. To check that our results cannot be explained by biases created by limited overlap in the support of the per capita income variable between presumed and informed consent countries or by unexplained differences in social norms between former communist countries and the rest of the sample, we re-estimated our regression excluding the four former communist eastern European countries from the data. For the restricted sample, the estimated regression coefficients on the presumed consent variable decreased slightly (to around .20) but remained within the same rough order of magnitude and not statistically different from the analogous coefficients for the entire sample.

<sup>28</sup> The only country that experiences a change of legislation in our sample is Sweden, which goes from an informed consent system to a presumed consent system in 1996. Ten years before, in 1986, Sweden had switched from presumed consent to informed consent. In our data cadaveric donation rates decrease steadily in Sweden during the informed consent period. This downwards trend seems to disappear after presumed consent legislation was reinstated in Sweden in 1996.

Table 3  
Presumed consent and social preferences (pooled OLS, 1993–2002)

	Dependent variable			
	Natural log of cadaveric donors per million population		Presumed consent country	
	(1)	(2)	(3)	(4)
Variables from Table 2, columns (6) and (7)				
Presumed consent	.2940** (.1334)	.3613** (.1158)		
Log GDP per capita	.2121 (.1558)	.2182 (.1479)	-.0551 (.1070)	-.0488 (.0810)
Catholic country	.1328 (.1589)		.2947* (.1524)	
Common law	.4175** (.1805)	.4265** (.1862)	-.6032** (.1738)	-.6856** (.1558)
Log of MVA and CVD deaths (per 1000 population)	.2740 (.2571)	.2975 (.2542)	.1936 (.2028)	.2890 (.2329)
Social preferences				
Log of blood donations (per 1000 population)	.4374* (.2500)	.3459 (.2770)	-.1726 (.3657)	-.4417 (.3605)
R-squared	.3705	.3494	.6497	.5881

Notes: All specifications include year fixed-effects. Standard errors (in parentheses) are clustered at the country level. The number of observations in all specifications is 139.

\* Indicates statistical significance at the 10% level.

\*\* Indicates statistical significance at the 5% level.

on the time-varying regressors between the pooled OLS and the fixed-effects specifications to test the hypothesis that country effects are uncorrelated with the presence of presumed consent laws.<sup>29</sup> *p*-Values are reported in Table 2 for regressions (3)–(8). Our specification test does not detect compelling evidence against the null hypothesis of absence of confounding country effects.

Although our specification test produces encouraging results about the validity of our estimates, it should be clear that the statistical power of our test will be low against deviations from the null hypothesis that affect mainly the estimated coefficient on the presumed consent law, but not the coefficients on the time-varying regressors. An alternative approach to the potential endogeneity of presumed consent laws is to include in our regressions a proxy for social preferences towards organ donation. We follow this approach in Table 3, where we use annual blood donations (per capita) as an indicator of social preferences towards organ donation.<sup>30</sup> Columns (1) and (2) of Table 3 reproduce the specifications in columns (6) and (7) of Table 2, but this time including the logarithm of annual blood donations per 1000 population as an additional regressor. As expected, donations of blood are positively associated with donations of organs. However, the estimated coefficients on the presumed consent variable increase relative to Table 2. This is at odds with the notion that nations with stronger preferences towards organ donation will be inclined to enact presumed consent laws. In fact, columns (3) and (4) of Table 3 show that social preferences towards organ donation proxied as the log of blood donations per 1000 population have, if anything, a *negative* correlation with the presence of presumed consent laws (although the coefficients on the log of blood donations per 1000 population in columns (3) and (4) are not significant at conventional test levels). Overall, the robustness analysis reported in Table 3 fails to detect any

<sup>29</sup> This test is implemented as a generalized Hausman specification test (see White, 1996).

<sup>30</sup> Arguably, donations of blood are motivated by the same philanthropic considerations as organ donations. Other indicators of the propensity to donate, like the fraction of the population who do unpaid work for voluntary organizations, produced similar results.

Table 4  
Organ shortage and potential increase in transplantation

Year	U.S.			UK		
	[25%, 30%] Increase in cadaveric transplantation (1)	Change in waiting list from previous year (2)	Deaths on waiting list (3)	[25%, 30%] Increase in cadaveric transplantation (4)	Change in waiting list from previous year (5)	Deaths on waiting list (6)
1994				[668, 802]	221	513
1995	[3947, 4736]	5969	3514	[695, 834]	372	533
1996	[3949, 4738]	6067	4015	[645, 773]	275	569
1997	[4011, 4814]	6230	4498	[644, 773]	184	555
1998	[4191, 5030]	6858	5192	[597, 716]	45	578
1999	[4203, 5043]	5888	6516	[597, 716]	169	545
2000	[4270, 5124]	6703	6144	[584, 700]	103	494
2001	[4340, 5208]	5580	6665	[585, 702]	63	433
2002	[4484, 5380]	2163	6679			

Notes: Columns (1) and (4) show 25 and 30% percentages of cadaveric transplantations for each particular year and for the U.S. and the UK, respectively. Columns (2) and (5) show the yearly change in the number of patients on organs waiting lists for the U.S. and the UK, respectively. Columns (3) and (6) show the number of deaths on the organs waiting lists for the U.S. and the UK, respectively.

evidence that the empirical results in Table 2 are confounded by cross-country differences in social norms towards organ donation.

On the whole, our empirical results suggest that presumed consent laws may greatly increase the supply of cadaveric organs for transplantation. However, it would be erroneous to interpret our results as evidence that presumed consent is the sometimes-portrayed silver-bullet for organ shortage. First, it is unlikely that a 25–30% increase in cadaveric donation would eliminate completely the organ shortage problem in some countries, like the U.S., although it would help considerably to alleviate it.<sup>31</sup> To see this assume that percentage increases in cadaveric donations translate roughly to percentage increases in cadaveric transplantation. Table 4 in column (1) shows the range for the number of additional transplantations that a 25–30% increase in cadaveric transplantations would have represented in the U.S. for the period of 1995–2002. For the same period, columns (2) and (3) show the (observed) yearly change in the number of patients on waiting lists and the yearly number of deaths on the waiting list, respectively. The sum of columns (2) and (3) provides an idea of the yearly variation in the amplitude of the gap between the demand and the supply of organs for transplantation. Columns (4)–(6) show the same variables for the UK and the period 1994–2001. The figures in Table 4 suggest that a 25–30% increase in cadaveric transplantation could potentially close the gap between the demand and the supply of organs in the UK, but not in the U.S. Moreover, it seems likely that an increase in the supply of cadaveric organs would be followed by a reduction in the supply of organs from living donors. Substitution

<sup>31</sup> Notice also that cross-country differences in the characteristics and enforcement of presumed consent legislation, as well as the implications of the behavioral model outlined in Section 3, suggest that there may be great deal of heterogeneity in the impact of presumed consent legislation across countries. Due to the limited amount of degrees of freedom in our data, such heterogeneity cannot be described in our empirical analysis. As a result, the impact of presumed consent legislation in the U.S. could differ significantly from the average 25 to 30% estimated for our sample. However, in the absence of a better estimate, we use the estimated average impact of 25–30% in our sample as a rough approximation to the impact of presumed consent legislation on cadaveric organ donation in the U.S. and the UK.

of organs from living donors would attenuate the effect of an increase in cadaveric organs on the size of the waiting lists.<sup>32</sup> Finally, many questions remain unanswered about how to implement a legislative change of this type. Although recent studies have reported successful transitions to a presumed consent default (see, for example, Michielsen, 1996), it seems likely that, in some countries, imposing a presumed consent law without first building sufficient social support could generate an adverse response to organ procurement efforts.

## 5. Conclusions

With some notable exceptions (see, e.g., Johnson and Goldstein, 2003, 2004), most previous studies have pointed out that, on average, presumed consent countries do not produce significantly higher organ donation rates. Moreover, several authors have hypothesized that this lack of correlation may be explained by the fact that presumed consent laws are rarely enforced and that, in practice, family consent is always required before organs are extracted.

In this article, we argue that legislative defaults on organ donation may affect the consent decisions of the families, even if they are not enforced. First, we use a simple model to illustrate how presumed consent laws may affect organ donation rates. In addition, using a panel of countries, we show that, once other determinants of organ donation are accounted for, cadaveric donation rates are 25–30% higher on average in presumed consent countries. The magnitude of this estimate does not vary much across the different specifications of our empirical model. Furthermore, using the panel structure of our data we are able to reject the presence of additive fixed effects.

Health professionals and organ donation activists in the U.S., Great Britain, and several other countries have proposed changing legislative defaults on organ donation to presumed consent. The results of this article suggest that presumed consent laws may alleviate organ shortages. Further research is needed, however, to better understand how societies perceive and respond to legislative changes of this nature.

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## Appendix A. Technical details

### A.1. Affiliated random variables

**Lemma 1.** *Suppose that the density of  $\varepsilon$  is log-concave and that  $\varepsilon$  and  $v$  are independent. Let  $z = v + \varepsilon$ . Then,  $z$  and  $v$  are affiliated, that is, for all  $\bar{z} \geq z$  and  $\bar{v} \geq v$*

$$f_{z,v}(\bar{z}, v)f_{z,v}(z, \bar{v}) \leq f_{z,v}(z, v)f_{z,v}(\bar{z}, \bar{v}),$$

where  $f_{z,v}$  is the density of  $(z, v)$ .

<sup>32</sup> This substitution effect is difficult to quantify because, to our knowledge, there do not exist estimates of the elasticity of substitution between living donor organs and cadaveric organs. In addition, it is possible that a higher availability of organs would be followed by an increase in the number of referrals to the waiting lists.

**Proof.** Because  $\varepsilon$  and  $v$  are independent, we obtain

$$f_{z,v}(z, v) = f_\varepsilon(z - v)f_v(v).$$

Therefore,  $z$  and  $v$  are affiliated if and only if

$$f_\varepsilon(\bar{z} - \underline{v})f_\varepsilon(\underline{z} - \bar{v}) \leq f_\varepsilon(\underline{z} - \underline{v})f_\varepsilon(\bar{z} - \bar{v}).$$

In other words, the density  $f_\varepsilon$  is of Pólya frequency of order 2, which is equivalent to log-concavity of  $f_\varepsilon$  (see An, 1998).  $\square$

**Lemma 2.** Suppose that  $z = v + \varepsilon$ , where  $\varepsilon$  is independent of  $v$  and has a log-concave density. Let  $z_1, z_P$  and  $c$  be real numbers with  $c > 0$ . Then,

$$V_I = \{v : vPr(z \leq z_1|v) > c\} \quad \text{and} \quad V_P = \{v : vPr(z \geq z_P|v) < -c\}$$

are either intervals or empty sets.

**Proof.** It can be shown that log-concave densities have convex supports (An, 1998). Let  $g(v) = vF_\varepsilon(z_1 - v)$ . Notice that  $g(0) = 0$ . In addition  $\lim_{v \rightarrow \infty} g(v) = 0$ , because log-concave densities have at most exponential tails (An, 1998). The right-hand-side derivative of  $g(v)$  is  $F_\varepsilon(z_1 - v) - vf_\varepsilon(z_1 - v)$ . Notice that  $F_\varepsilon(z_1 - v) - vf_\varepsilon(z_1 - v)$  converges to one when  $v \rightarrow -\infty$ , and it converges to zero when  $v \rightarrow \infty$ . If the support of  $\varepsilon$  is bounded from below,  $F_\varepsilon(z_1 - v) - vf_\varepsilon(z_1 - v)$  is equal to zero if  $z_1 - v$  is to the left of the support of  $\varepsilon$ . If the support of  $\varepsilon$  is bounded from above,  $F_\varepsilon(z_1 - v) - vf_\varepsilon(z_1 - v)$  is equal to one if  $z_1 - v$  is to the right of the support of  $\varepsilon$ . If  $z_1 - v$  belongs to the support of  $\varepsilon$ , then  $F_\varepsilon(z_1 - v) - vf_\varepsilon(z_1 - v)$  has the same sign as  $F_\varepsilon(z_1 - v)/f_\varepsilon(z_1 - v) - v$ . By the properties of log-concave densities, the ratio  $F_\varepsilon(z_1 - v)/f_\varepsilon(z_1 - v)$  is a non-increasing function of  $v$ . Thus,  $F_\varepsilon(z_1 - v)/f_\varepsilon(z_1 - v) - v$  is decreasing, so the function  $g(v)$  is quasi-concave. Now, the result for  $V_I$  follows from the properties of quasi-concave functions. The proof for  $V_P$  is analogous.  $\square$

### A.2. Solution of the model under normality

Assume that  $v \sim N(\mu_v, \sigma_v^2)$  and  $\varepsilon \sim N(0, \sigma_\varepsilon^2)$ . Consider first the informed consent scenario:

$$Pr(z \leq z_1|v) = Pr\left(\frac{\varepsilon}{\sigma_\varepsilon} \leq \frac{z_1 - v}{\sigma_\varepsilon} \middle| v\right) = \Phi\left(\frac{z_1 - v}{\sigma_\varepsilon}\right),$$

where  $\Phi$  represents the cumulative distribution function of the standard normal distribution. For this case, the set of individuals registering under informed consent legislation,

$$V_I = \left\{v : v\Phi\left(\frac{z_1 - v}{\sigma_\varepsilon}\right) > c\right\},$$

is an interval  $[\underline{c}_1(z_1), \bar{c}_1(z_1)]$  or the empty set. Given that

$$f_{v|z}(v) = \frac{f_{z|v}(z)}{f_z(z)} f_v(v) = \frac{f_\varepsilon(z - v)f_v(v)}{f_z(z)},$$



we obtain:

$$E[v|vPr(z \leq z_I|v) < c, v + \varepsilon = z_I] \propto \int_{-\infty}^{\underline{z}_I(z_I)} v \frac{1}{\sigma_\varepsilon} \frac{1}{\sigma_v} \phi\left(\frac{z_I - v}{\sigma_\varepsilon}\right) \phi\left(\frac{v - \mu_v}{\sigma_v}\right) dv + \int_{\bar{z}_I(z_I)}^{+\infty} v \frac{1}{\sigma_\varepsilon} \frac{1}{\sigma_v} \phi\left(\frac{z_I - v}{\sigma_\varepsilon}\right) \phi\left(\frac{v - \mu_v}{\sigma_v}\right) dv,$$

where  $\phi$  represents the probability density function of the standard normal distribution. Therefore, the solution for  $z_I$  is given by:

$$\int_{-\infty}^{\underline{z}_I(z_I)} v \phi\left(\frac{z_I - v}{\sigma_\varepsilon}\right) \phi\left(\frac{v - \mu_v}{\sigma_v}\right) dv + \int_{\bar{z}_I(z_I)}^{+\infty} v \phi\left(\frac{z_I - v}{\sigma_\varepsilon}\right) \phi\left(\frac{v - \mu_v}{\sigma_v}\right) dv = 0.$$

Notice that

$$\phi\left(\frac{z_I - v}{\sigma_\varepsilon}\right) \phi\left(\frac{v - \mu_v}{\sigma_v}\right) \propto \exp\left\{-\frac{1}{2}\left[\left(\frac{z_I - v}{\sigma_\varepsilon}\right)^2 + \left(\frac{v - \mu_v}{\sigma_v}\right)^2\right]\right\}.$$

In addition,

$$\begin{aligned} \left(\frac{z_I - v}{\sigma_\varepsilon}\right)^2 + \left(\frac{v - \mu_v}{\sigma_v}\right)^2 &= \frac{z_I^2 + v^2 - 2z_I v}{\sigma_\varepsilon^2} + \frac{\mu_v^2 + v^2 - 2\mu_v v}{\sigma_v^2} \\ &= \frac{1}{\sigma_\varepsilon^2 \sigma_v^2} \{(\sigma_v^2 + \sigma_\varepsilon^2)v^2 - 2(\sigma_v^2 z_I + \sigma_\varepsilon^2 \mu_v)v + (\sigma_v^2 z_I^2 + \sigma_\varepsilon^2 \mu_v^2)\} \\ &= \frac{\sigma_\varepsilon^2 + \sigma_v^2}{\sigma_\varepsilon^2 \sigma_v^2} \left\{v^2 - 2\left(\frac{\sigma_v^2 z_I + \sigma_\varepsilon^2 \mu_v}{\sigma_\varepsilon^2 + \sigma_v^2}\right)v + \frac{\sigma_v^2 z_I^2 + \sigma_\varepsilon^2 \mu_v^2}{\sigma_\varepsilon^2 + \sigma_v^2}\right\} \\ &= \frac{\sigma_\varepsilon^2 + \sigma_v^2}{\sigma_\varepsilon^2 \sigma_v^2} \left\{v^2 - 2\left(\frac{\sigma_v^2 z_I + \sigma_\varepsilon^2 \mu_v}{\sigma_\varepsilon^2 + \sigma_v^2}\right)v + \left(\frac{\sigma_v^2 z_I + \sigma_\varepsilon^2 \mu_v}{\sigma_\varepsilon^2 + \sigma_v^2}\right)^2\right\} + C, \end{aligned}$$

where  $C$  is some constant. As a result:

$$\phi\left(\frac{z_I - v}{\sigma_\varepsilon}\right) \phi\left(\frac{v - \mu_v}{\sigma_v}\right) \propto \phi\left(\frac{v - \mu_I}{\sigma}\right),$$

where

$$\mu_I = \frac{\sigma_v^2 z_I + \sigma_\varepsilon^2 \mu_v}{\sigma_\varepsilon^2 + \sigma_v^2} \quad \text{and} \quad \sigma^2 = \frac{\sigma_\varepsilon^2 \sigma_v^2}{\sigma_\varepsilon^2 + \sigma_v^2}.$$

It is easy to show that

$$\begin{aligned} \int_{-\infty}^{\bar{v}} v \frac{1}{\sigma} \phi\left(\frac{v - \mu}{\sigma}\right) dv &= \mu \Phi\left(\frac{\bar{v} - \mu}{\sigma}\right) + \sigma \int_{-\infty}^{(\bar{v} - \mu)/\sigma} y \phi(y) dy \\ &= \mu \Phi\left(\frac{\bar{v} - \mu}{\sigma}\right) - \sigma \phi\left(\frac{\bar{v} - \mu}{\sigma}\right), \end{aligned}$$

and

$$\int_{\bar{v}}^{+\infty} v \phi\left(\frac{v - \mu}{\sigma}\right) dv = \mu \left(1 - \Phi\left(\frac{\bar{v} - \mu}{\sigma}\right)\right) + \sigma \phi\left(\frac{\bar{v} - \mu}{\sigma}\right).$$

Hence, the solution for the cutoff point,  $z_I$ , is given by:

$$\begin{aligned} & \mu_I \Phi \left( \frac{c_I(z_I) - \mu_I}{\sigma} \right) - \sigma \phi \left( \frac{c_I(z_I) - \mu_I}{\sigma} \right) \\ & + \mu_I \left( 1 - \Phi \left( \frac{\bar{c}_I(z_I) - \mu_I}{\sigma} \right) \right) + \sigma \phi \left( \frac{\bar{c}_I(z_I) - \mu_I}{\sigma} \right) = 0. \end{aligned}$$

For the presumed consent case, the result is analogous:

$$\begin{aligned} & \mu_P \Phi \left( \frac{c_P(z_P) - \mu_P}{\sigma} \right) - \sigma \phi \left( \frac{c_P(z_P) - \mu_P}{\sigma} \right) \\ & + \mu_P \left( 1 - \Phi \left( \frac{\bar{c}_P(z_P) - \mu_P}{\sigma} \right) \right) + \sigma \phi \left( \frac{\bar{c}_P(z_P) - \mu_P}{\sigma} \right) = 0. \end{aligned}$$

with

$$\mu_P = \frac{\sigma_v^2 z_P + \sigma_\varepsilon^2 \mu_v}{\sigma_\varepsilon^2 + \sigma_v^2}.$$

## Appendix B. Data sources and sample selection

International data on cadaveric organ donation rates come from the Spanish National Organ Transplantation Organization (ONT, 2003) and the Transplant Procurement Management Organization (TPM, 2003). Disaggregated data for the UK and Ireland were provided by Kerri Burbidge from UK Transplant. Data on organ donation for the U.S. come from OPTN (2003). Data on organ donation rates for New Zealand come from ANZOD (2003). For the U.S., data on cadaveric transplantation, size of waiting lists, and number of deaths on waiting lists come from OPTN (2003). For the UK, data on cadaveric transplantation and size of waiting lists come from UK Transplant (2003), and data on deaths on waiting lists was provided to us by Kerri Burbidge from UK Transplant.

Data on legislative defaults on cadaveric organ donations were compiled from a variety of sources by consulting the legal literature. In some instances, when legislative data for a particular country could not be found in the literature or the information was ambiguous, we contacted the country agency in charge of organ donation management to request this information. Detailed information about legislative defaults on cadaveric organ donation is presented in Appendix C.

We obtained data on GDP, population, health expenditures and number of hospital beds from the World Bank Development Indicators (World Bank, 2003a). Schooling data appear in the World Bank Education Statistics (World Bank, 2003b). The number of deaths caused by traffic accidents and cerebro-vascular failures were compiled from the World Health Organization Mortality Database (World Health Organization, 2003). We obtained data on religious beliefs and legal systems from the CIA (2003). Data on blood donation refer to the year 2001. For Europe and North America these data come from FIODS (2004). Data on blood donation for New Zealand was provided by Paul Hayes from the New Zealand Blood Service. Data on the fraction of the population doing unpaid work for voluntary organizations come from the World Values Survey (Inglehart et al., 2004).

For the 36 countries listed in Appendix C and in Fig. 3, and for the year 2002, we obtained data on cadaveric organ donation rates and legislative defaults on cadaveric organ donation. Fourteen of

the 36 countries were discarded for the regression analysis in Section 4. Countries were discarded for several reasons. First, to reduce heterogeneity in social norms we restricted our sample to Western Christian countries (Catholic and Protestant). This eliminated from our sample Bulgaria, Greece, Israel, Japan, Romania and Turkey. Some countries, Bulgaria, Croatia, Cyprus, Estonia, Japan, Latvia, Lithuania and Romania, were discarded also because of data availability problems. An additional reason to discard Japan was that heart-beating cadaveric donation was outlawed in Japan until recently. We also discarded small countries with populations of less than one million, like Cyprus and Luxembourg. We discarded Switzerland, because, although this country has an informed consent default at the federal level, legislation on organ donation defaults varies by region. Finally, some countries produce extremely modest levels of organ transplant activity, which, in some cases, may be caused by lack of transplantation facilities. If capacity constraints limit the transplantation activity in a country at a very low level, legislative defaults are unlikely to influence donation rates, because organs will not be used for transplantation. Including in our sample countries with capacity constraints on organ transplantation would bias downward our estimate of the effect of presumed consent laws in countries where capacity constraints are not binding. For this reason, we discarded those countries which never reached a rate of 20 kidney transplants per million population per year. These countries are: Croatia, Greece, Slovak Republic, Romania and Turkey. In principle, this could create a bias in our estimates if the cause of low transplant rates in those countries is a low cadaveric organ donation rate. However, we chose the rate of kidney transplants to select our sample because kidneys can be procured from living donors if transplant facilities are available. In practice, it is capacity, and not cadaveric donation, that is likely to be the binding constraint for countries with fewer than 20 kidney transplants per million population per year. In the U.S., for example, transplants of kidneys procured from living donors routinely surpass the 20 pmp rate. In Cyprus, where cadaveric donations are almost non-existent, the rate of kidney transplants from living donors consistently exceeds the 55 pmp mark.

The 22 countries used in our regression analysis are: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, The Netherlands, New Zealand, Norway, Poland, Portugal, Slovenia, Spain, Sweden, United Kingdom and the United States. The data cover the period 1993–2002 for all countries, with the exceptions of the Czech Republic (1994–2002), Portugal (1994–2002), and Slovenia (1998–2002). We discarded the year 1993 for the Czech Republic because of inconsistencies in the data on deaths caused by traffic accidents. We discarded the year 1993 for Portugal because this country changed legislation in 1993. For Slovenia, we were able to obtain reliable data on the number of cadaveric donors only for the period 1998–2002.

### **Appendix C. Legislative defaults on cadaveric organ donation**

**Australia:** Informed consent country by Law of 1982. Has a donor registry since November 2000.

**Austria:** Presumed consent country by Law of 1 June 1982, Section 62A. Has a non-donor registry since 1995.

**Belgium:** Presumed consent country by Law of 13 June 1986. Has a combined registry since 1987. Families should be informed and could potentially object to organ donation.

**Bulgaria:** Presumed consent country by Law of 1996. In practice, consent from the next of kin is required.

**Canada:** Informed consent country by Uniform Human Tissue Donation Act of 1980. (The exact date depends on each state: Alberta, Human Tissue Act 1967. British Columbia, Human Tissue

Gift Act 1974. Manitoba, Human Tissue Gift Act 1987. New Brunswick, Human Tissue Gift Act 1973 and Human Tissue Gift Act 1986. Newfoundland, Act No. 78 of 1966. Nova Scotia, Human Tissue Gift Act 1964. Ontario, Human Tissue Gift Act 1982. Prince Edward Island, Human Tissue Donation Act 1992. Quebec, Civil Law of 1993 Articles 42, 43, 44.)

**Croatia:** Presumed consent country by Law of 2000; was already a presumed consent country since 1989. No donor registry in place. Family consent is always requested.

**Cyprus:** Presumed consent country by Law No. 97 of 1987.

**Czech Republic:** Presumed consent country by Law of 1984. A new law was passed on September 2002 that established a stronger version of presumed consent. No registry in place for non-donors.

**Denmark:** Informed consent country by Law No. 402v of 13 June 1990. Previously, Denmark was a presumed consent country by Law No. 246 of 9 June 1967. Denmark has a combined registry since 1990.

**Estonia:** Presumed consent country.

**Finland:** Presumed consent country by Law No. 355 of 26 April 1985 and Ordinance No. 724 of 23 August 1985.

**France:** Presumed consent country by Caillavet Law (No. 76-1181) of 22 December 1976 and the Bioethics Law No. 94-654 of 29 July 1994. France has a non-donor registry since 1990, as well as a donor card system. In practice, families can override the intent of deceased relatives.

**Germany:** Informed consent country by Act on the Donation, Removal and Transplantation of Organs of 5 November 1997. Previously, Germany was also informed consent. There is no registry in place.

**Greece:** Presumed consent country by Law 2737 of 27 August 1999. It was already a presumed consent country by Law of 1978 (No. 821) modified in 1983 (Law No. 1383 of the 2 August 1983).

**Hungary:** Presumed consent country by Ordinance No. 18 of 4 November 1972. Has a non-donor registry since 1999.

**Ireland:** Informed consent country. The Republic of Ireland does not have a law regulating organ donation, but follows UK guidelines.

**Israel:** Presumed consent country by the Law of Anatomy and Pathology of 1953.

**Italy:** Presumed consent country by Penal Code, Articles 581–585 and Law No. 458 of 26 June 1967, Law No. 644 of 2 December 1975. A new law of presumed consent was approved on 1 April 1999. Has a combined registry since 2000. In practice, families are consulted before organs are extracted.

**Japan:** Informed consent country by Law No. 104 of 16 July 1997. Before 1997, heart beating donors were not allowed. According to Section 6(1) of the Law of 16 July 1997, families can veto decisions of relatives to donate.

**Latvia:** Presumed consent country.

**Lithuania:** Informed consent country.

**Luxemburg:** Presumed consent country by Law of 25 November 1982.

**The Netherlands:** Informed consent country by Law of 24 May 1996. Before 1996, the country was already informed consent. There is a combined registry in place since 1998. Families decide on donation for non-registered relatives, but have a small influence in the decision for registered relatives.

**New Zealand:** Informed consent country by the Human Tissue Act of 1964.

**Norway:** Presumed consent country by Law No. 6 of 9 February 1973. There is no registry in place. Families are consulted before organ extraction and can potentially refuse. If no relatives

are found, organs can be extracted. Patients organizations have introduced donor cards, but they do not have legal status.

**Poland:** Presumed consent country by Article No. 91-408 of 30 August 1990 law and Article 4 of October 1995 law. There is a non-donor registry in place since 1996.

**Portugal:** Presumed consent country by Law No. 12 of 22 April 1993. There is a non-donor registry in place since 1994.

**Romania:** Informed consent country by Law of 1998. Previously, Romania was already an informed consent. There is a combined registry in place since 1996.

**Slovak Republic:** Presumed consent country by Law of 24 August 1994, Section 47.

**Slovenia:** Presumed consent country by Law of 2000. Previously, Slovenia was already presumed consent, by the Law of Transplantation of Human's Body Parts of 1996.

**Spain:** Presumed consent country by Law No. 30 of 30 October 1979. In practice, organs are extracted only with the consent of families.

**Sweden:** Presumed consent country by Law of 1996. Between 1987 and 1996, Sweden was an informed consent country. Families can potentially veto donation if the wishes of the deceased relative are not known. There is a combined registry in place, although it is used mainly as a non-donor registry.

**Switzerland:** Informed consent country by Federal Order of 22 March 1996. However, the country is divided in cantons that have their own legislation. The following cantons have presumed consent legislation: Appenzell (laws of 1974 and 1992), Argovie (1987), Bale-Campagne (1988), Bale-Ville (1981), Berne (1984), Geneva (1996), Grisons (1984), Lucerne (1981), Neuchâtel (1995), Nidwald (1981), St-Gall (1979), Turgovia (1985), Valais (1996), Vaud (1985) and Zurich (1991).

**Turkey:** Presumed consent country by Law No. 2238 of 3 June 1979. In practice, written authorization from families has to be obtained before organ extraction.

**United Kingdom:** Informed consent country by The Human Tissue Act 1961 and the The Human Organ Transplants Act 1989. Has a donor registry since 1994.

**United States:** Informed consent country by the Uniform Anatomical Gift Act of 1968, revised in 1987. There are donor registries in several states; donor registries are being considered in other states.

A longer version of this appendix, including sources, is available from the authors on request.

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