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Removing financial barriers to organ and bone marrow donation: The effect of leave and tax legislation in the U.S.☆

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ABSTRACT

Many U.S. states have passed legislation providing leave to organ and bone marrow donors and/or tax benefits for live and deceased organ and bone marrow donations and to employers of donors. We exploit cross-state variation in the timing of such legislation to analyze its impact on organ donations by living and deceased persons, on measures of the quality of the transplants, and on the number of bone marrow donations. We find that these provisions do not have a significant impact on the quantity of organs donated. The leave laws, however, do have a positive impact on bone marrow donations, and the effect increases with the size of the population of beneficiaries and with the generosity of the legislative provisions. Our results suggest that this legislation works for moderately invasive procedures such as bone marrow donation, but these incentives may be too low for organ donation, which is riskier and more burdensome.

1. Introduction

In virtually every country, the demand for organs and bone marrow far exceeds supply, leaving many patients to spend years and even die waiting for donated organs or bone marrow. In the U.S., for instance, where more than 100,000 people are on the waiting list for an organ transplant, the median wait-time until death or transplantation was 276 days for a liver and 547 days for a kidney in 2005, and only slightly over 60% of individuals waitlisted ever received an organ. Approximately 300 individuals die each year because they cannot find a matching bone marrow donor.[1] In addition to the implications for transplant candidates, a kidney transplant also saves at least $90,000 over the life of the individual relative to on-going dialysis treatment (Matas and Schnitzler, 2003).

This supply shortage and the associated costs, as well as the loss in quality of life and even life itself drive the ongoing debate as to whether donors should receive some form of compensation in order to increase organ and bone marrow donation. Concerns about exploitation of the poor and sick, adverse selection, motivational crowding out, and a general "repugnance" toward the commercialization of body parts have influenced the debate heavily (Frey, 1993; Roth, 2007; Titmuss, 1971).[2] Some scholars and policymakers oppose any form of explicit reward for organ donors whereas others advocate direct monetary payments. Becker and Elias (2007), for instance, estimate that amounts of $15,000 and $38,000 would enable markets for kidneys and livers, respectively,

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[1] These statistics are taken from the Organ Procurement and Transplantation Network (OPTN) for organs, and from Bergstrom et al. (2009) (based on National Marrow Donor Program (NMDP) data) for bone marrow.

[2] Byrne and Thompson (2001) identify additional mechanisms that could lead to perverse effects of incentives, including time-inconsistency issues related to rewards for donor registration.

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to clear.[3] Other studies indicate that some form of non-cash, in-kind rewards could help reduce the supply shortage of human organs and tissue (Frey, 1993; Lacetera and Macis, 2010, 2013; Leider and Roth, 2010; Rodrigue et al., 2009; Roth et al., 2004). Singapore and Israel have instituted priority rules for organ donors to reward those with signed donor cards and their families (Biyar, 2011; Duenwald and Shipley, 2011).[4] Israel also allows direct payments to donor families to "memoralize" post-cadaveric donation, as well as more direct forms of compensation such as an exemption from health insurance premiums for living donors (Levush, 2010; Satel, 2010). Several European countries make organ donation an opt-out rather than an opt-in decision; according to some observers, this has led to significantly higher organ donation rates (Abadie and Gay, 2006).

In this paper, we present a comprehensive study of the impact of legislative efforts in the U.S. to mitigate the organ and bone marrow supply shortage by removing disincentives to donation without offering direct compensation, primarily through work leave legislation and tax credits and deductions. Specifically, between 1989 and 2009, a number of U.S. states passed legislation that grants paid or unpaid leave to state government employees, paid and unpaid leave to private firm employees, tax deductions to individuals who donate their organs or bone marrow, and tax credits to employers for promoting donation.

We quantify the effects of these types of legislation on both organ and bone marrow donations. For organ donations, we focus on the two most commonly donated organs, livers and kidneys, which account for over 80% of all organs donated and almost 100% of donations from live donors. In addition, the gap between supply and demand is much larger for kidneys and livers relative to hearts, lungs, pancreas, and intestines.[5] Even though the tax and leave legislation apply primarily to living donors, we assess whether cadaveric donations are affected as well. We do so for three main reasons: first, if donations from living and deceased donors follow a common time trend, the donations by deceased donors might be used as a "control" group. Second, these types of donations might actually be substitutes (Fernandez et al., 2013). Moreover, the introduction of the legislation might be accompanied by a spread of information on organ donation in general, which might induce more individuals to become registered organ donors. If so, legislation targeting one type of donors might have effects on the other type as well. We also study whether these laws affect organ quality, as measured by the state-level post-transplant graft survival rate. For bone marrow donations, we explore potential differential effects by donation method: aspiration or apheresis.[6]

A priori, if the incentives implied by the legislation were to have a positive impact on donation, we should expect these laws to influence bone marrow donors more than organ donors. Bone marrow donation has a much lower risk of complications and death than does organ donation, and is much less burdensome to the donor in terms of recovery time, pain, and suffering. Also, bone marrow regenerates and can be donated multiple times, whereas kidneys never re-grow. In the case of livers, which also regenerate, no cases of multiple donations are documented in the literature or the data and any prior hepatobiliary surgery complicates future transplant surgery should the donor ever need a liver transplant (Maddrey and Van Thiel, 1988). In other words, bone marrow donation is less costly for a donor; therefore, at the margin, moderate incentives should tip the trade-off toward deciding to donate in the case of bone marrow more than they do for organs. For similar reasons, we differentiate between livers and kidneys within organ donation and, within bone marrow, aspiration and apheresis. The risk of complications or death and the recovery period are greatest for liver donation and lowest for apheresis donations (Confer et al., 2003; Karanes et al., 2003; Muzaale et al., 2011; Segev et al., 2010).

Our empirical strategy exploits the fact that different states have introduced legislation at different points in time. We take advantage of the longitudinal nature of our dataset to allay potentially important selection, endogeneity, and omitted variable concerns. In our regression models, we include state fixed effects as well as state-specific time trends to ensure that we are controlling for omitted time-invariant factors and for selection into adopting the legislation based on the level and growth rate of the outcome variables (Ashenfelter and Card, 1985; Heckman and Hotz, 1989). To probe the validity of our identification strategy, we assess whether pre-existing trends in the demand for organs predict the adoption of legislation.

Our results indicate that the legislation had no overall effect on the number of organ donations. This result is robust across a variety of specifications and sub-samples, and holds also when we allow the legislation to affect outcomes with one- or two-year lags. In contrast, and consistent with our prior, we do find a positive effect of leave legislation on bone marrow donation. Specifically, we find a positive effect of leave legislation for state employees on bone marrow donations, provided that a sufficient share of a state's labor force is state-employed (i.e., when the size of the population actually affected by the law is larger). Our estimated coefficients imply that leave legislation for state employees has a positive effect on bone marrow donations if state employees represent about 4% of the labor force, which is the case for 30 states, of which 18 passed laws granting leave to state employees. To probe our interpretation that the size of the incentive matters, we check whether the effect of the leave legislation increases with its generosity, and we find that the positive effect of the leave legislation for bone marrow donations is stronger when the leave is longer and when it is paid rather than unpaid.

We have also considered the effects of the legislation on organ quality, as proxied by six-month and three-year post-transplant graft survival rates, to test if the legislation is causing shifts in the underlying quality distribution of organs used for transplantation even in the absence of changes in the overall number of transplants. This could happen if the legislation has opposed effects on different types of living donors. For example, the laws might lead to increased donation among the less intrinsically motivated donors and decreased donation among the more intrinsically motivated. If the latter types of donors are of higher "quality" (Titmuss, 1971), the incentives implied by the legislation may lead to a shift in the overall quality of organs donated. We find an overall positive effect for three-year-survival from leave for state employees and tax credits for employers, although the estimated coefficients are only marginally statistically significant. We also found a negative effect on three-year survival of recipients of organs from living

[3] The only country without an organ supply shortage is Iran, where the sale of kidneys is legal since 1988. The Iranian government pays $1200 and provides health insurance for one year to cover surgery-related conditions. In addition, the vendor receives between about $2300 and $4500 either from the recipient or one of several designated charitable organizations (Hippen, 2008). "Gray" market prices for kidneys posted by websites offering to coordinate procurement and transplantation internationally (a.k.a. "transplant tourism") range from $14,000 to $85,000 (Shimazono, 2007).

[4] New U.S. policies do provide priority for prior living donors on the kidney transplant waitlist, effective 05/24/2012. http://optn.transplant.hrsa.gov/PoliciesandBylaws2/policies/pdfs/policy_172.pdf.

[5] The Organ Procurement and Transplantation Network.http://optn.transplant.hrsa.gov/latestData/advancedData.asp. Accessed 07/04/2012.

[6] In apheresis, a prospective donor undergoes five days of drug injections to stimulate the production of specialized blood cells, which are then filtered out of the donor's blood over the course of several hours, much as in plasma donation. The alternative method of aspiration requires removal of actual bone marrow from the hip of the donor, a more painful and risky procedure than apheresis.

donors and a positive effect on the same group of tax credits to employers. These results suggest that the laws may affect the distribution of organs donated or the distribution of organs used even in the absence of an overall effect on the quantity of organs, but there is no systematic evidence of adverse selection induced by the legislation.

This study contributes to a growing literature in economics on organ and bone marrow donation. Two papers have looked at the effects of a variety of traffic safety laws on cadaveric organ donation, such as motorcycle helmet laws, primary seat belt enforcement laws, and speed limits (Dickert-Conlin et al., 2012; Fernandez et al., 2013). Kessler and Roth (2012, 2013a) studied the effect of priority rules both theoretically and experimentally, and Lavee et al. (2012) found positive effects of the priority policy in Israel. Kessler and Roth (2013b) found that providing individuals with multiple opportunities to declare their organ donor registration status leads to more individuals joining registries. A number of studies (e.g., Roth et al., 2004, 2005a, 2005b) have analyzed the use of kidney exchanges, which cross-match incompatible donor and recipient pairs to create compatible donor-recipient pairs. Bagozzi et al. (2001) documented differences in bone marrow donation across different cultures, and Bergstrom et al. (2009, 2012) analyzed the optimal size and racial composition of bone marrow registries. Although the effects of non-cash legislated incentives on many types of pro-social behavior, including health-related activities (e.g., blood donation; see Lacetera et al., 2013a), have now been studied extensively, the literature has just begun to study the effects of such legislation on the much more "costly" pro-social behavior involved in organ and bone marrow donation.

The overall scarcity of organ and bone marrow donors and the difficulty in matching between donors and recipients make "natural experiments" such as the ones exploited in this paper particularly important for determining how well such legislation performs in solving the severe organ and bone marrow shortage problem existing in the U.S. A few closely related studies exist. Venkataramani et al. (2012) examine the effect of tax deductions for individuals on living organ donation. Bilgel (2011) and Wellington and Sayre (2011) study tax deductions for individuals and leave legislation for state employees, but consider only organs and not bone marrow (Bilgel) and only kidneys (Wellington and Sayre). In our paper, we present a comprehensive analysis including kidneys and livers, and all types of legislation (leave for state employees, leave for private employees, tax deductions to individuals and tax credits to employers for donation-promoting activities). Boulware et al. (2008) include all four types of legislation, but only consider kidney donations, and do not control for state-specific time-invariant factors, factors that vary over time but are common to all states, or pre-existing trends in state-level donation rates. Our paper employs a more stringent and complete empirical specification compared to these earlier papers. We also explore whether these laws affected the quality of organs donated. Perhaps most importantly, our paper is the first to examine the effects of these policies on bone marrow donations, for which theoretical considerations lead us to anticipate stronger effects. In fact, like in our study, these other papers document no effect of the laws examined on organ donation. In addition to being relevant for policy and health considerations, the positive effect we find on bone marrow donation supports an "incentive size" explanation for the zero result on organs, namely that the incentives may be too low for more "costly" donations but may work for less invasive procedures such as bone marrow donation. Our finding that the effect increases with the generosity of the leave legislation further corroborates this interpretation. This is consistent with the positive effect found by Lacetera and Macis (2013) of paid leave on an even less invasive procedure, blood donation.[7] In all, our empirical identification strategy, as well as the focus on both organs and marrow and on both quantity and quality, allow us to make significant progress in understanding how the existing legislation affects the supply of organs and marrow, and more generally whether financial incentives might be a viable and effective option to increase supply.

In Section 2 we offer background information on the history of organ and bone marrow donation and the associated legislation. In Section 3 we describe the data, and in Section 4 we present and discuss our empirical strategy. We report the results in Section 5, and in Section 6 we discuss some implications of our results and conclude.

2. Organ and bone marrow donation and associated legislation

2.1. Background

In 1954, the first successful living donor kidney transplant was performed, followed by the first successful cadaveric donor kidney transplant in 1962. The first successful cadaveric liver transplant occurred in 1967 between identical twins. Bone marrow was first successfully transplanted in 1973. A living donor was not successfully used in liver transplantion until 1989.[8]

Long-term dialysis treatment became available in 1960, greatly extending the life expectancy of individuals with renal failure and with that, the demand for kidney transplants. The Food and Drug Administration's approval of the immunosuppressant cyclosporine in 1983 transformed organ transplantation from a high-risk experimental procedure with almost certain organ rejection to a common treatment for organ failure. In the late 1990s, laparoscopic surgery greatly reduced the pain and recovery time for live kidney donors.[9]

As science and technological progress developed ever more effective transplantation methods, policymakers sought, in a variety of ways, to facilitate the use of these new methods and influence the exchange of organs. Medicare has paid for dialysis since 1972, kidney transplants since 1978, and liver transplants since 1990.[10] As for bone marrow, Medicare began coverage in 1978 and expanded it in 1985 and in 2010. Federal law increased the supply of deceased donor organs by extending the definition of "death" to include "brain death" in 1981. In 1984, the National Organ Transplant Act banned the sale of organs and bone marrow, and the Organ Procurement and Transplantation Network (OPTN) was established to promote organ donation, facilitate the allocation of organs, and serve as a central repository of organ donation-related data. OPTN's bone marrow counterpart, the National Marrow Donation Program

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[7] Through the UNOS data request process rather than the OPTN's online data tool, we were able to obtain transplant-level data, which we aggregated at the state level. With the exception of Boulware et al. (2008) the prior studies cited above use data aggregated at the donation service area level, not the state level. Although donation service areas usually align with state boundaries, 32 of the 58 donation service areas in the U.S. include counties from more than one state.

[8] We focus here on the two human organs and one type of tissue included in this study: kidneys, livers, and bone marrow. Lungs, hearts, and intestines can be donated by living donors, but this occurs extremely rarely, so we drop these from our sample. (Deceased donors are required for heart transplants except for the case of domino transplants [i.e., a heart-lung recipient donates his or her heart to another recipient]).

[9] http://www.organtransplants.org/understanding/history/index.html.

[10] Prior to 1990, Medicare covered liver transplants on a case-by-case basis. In 1990, this coverage was expanded to all end-stage liver disease patients except those with Hepatitis B or liver cancer. In 1996, Hepatitis B became covered, and in 2001 Medicare began covering hepatocellular carcinoma, but other forms of cancer remain uncovered.

(NMDP), was established two years later in 1986. In 1994, a federal law was passed to provide leave of absence for bone marrow (5 days) and organ (30 days) donation by federal employees. Federal law also started requiring hospitals to notify organ procurement organizations of all eligible deaths in 1998, so that all might have the opportunity to donate.

Although organs from deceased donors are still the main source for transplants, this supply is inherently limited by the death rate, the type of deaths, and the decomposition process. Only a small percentage of deaths yield viable organs, and although improvements in storage and transportation of organs have occurred, kidneys are only viable for up to 24 h and livers for up to 12 h without a living blood supply (Institute of Medicine, 1999). Despite over two million deaths in the U.S. in 2009, eligible deaths documented by UNOS totaled only 9827.[11] These deaths yielded organs used in 11,285 kidney transplants and 6098 liver transplants, supplemented with 6387 live kidney donations and 219 live liver donations. Meanwhile, 33,663 people joined the kidney waitlist and 10,706 joined the liver waitlist in 2009. Bone marrow donations must come from living donors exclusively, but individual donors can donate more than once, making the bone marrow supply less inherently limited than the supply of donor organs.

Donating an organ or bone marrow exacts financial costs and at least some risk of pain and immediate and future health risks. Even though payers of organ and bone marrow transplants also pay the costs of recovery, both types of donors face costs in terms of time away from work, travel, and lodging. Prohibited by law from paying direct compensation to donors, states have attempted to address the organ shortfall by offsetting the incidental costs associated with donation and protecting employees from employer retaliation for work absences related to donation. The health risk remains: 3.1 deaths per 10,000 donors for kidney donors and as high as 17 per 10,000 for liver donors (Muzaale et al., 2011; Segev et al., 2010). In addition, donors may experience non-fatal complications including pain, infection, and hemorrhaging.[12]

2.2. Leave and tax legislation

States have attempted to address the organ and bone marrow shortfalls through a variety of methods that diminish the financial barriers to donation: leave for state employees, leave for private employees, tax credits for employers, and tax deductions for individuals. In general, laws granting leave offer up to 30 days for organ donation and up to one week for bone marrow donation. Tax deductions for individuals cover non-medical donation-related expenses up to a maximum of $10,000. Tax credits for employers cover donation-promoting activities, including the provision of paid leave to donors. Table 1A (organs) and Table 1B (bone marrow) list the dates of passage for each type of legislation by state (details and legal references by state are listed in Table A1 in the online Appendix: Lacetera et al., 2013b). In 1989, Colorado passed the first relevant legislation providing state employees leave for the donation of an organ or bone marrow. Since then, most states have implemented legislation removing financial disincentives to donation through leave or tax legislation. For organ donation, thirty-one states offer leave for state employees, seven states offer leave for private employees, sixteen states give tax deductions to individuals and three states provide tax credits to employers. For bone marrow donations, thirty-three states offer leave for state employees, eleven states offer leave for private employees, fifteen states give tax incentives to individuals and four states give employers tax credits for donation-promoting activities (further details are in the online Appendix).

3. Data and descriptive statistics

3.1. Organs

Patient-level data on kidney and liver transplants come from the Organ Procurement and Transplantation Network (OPTN). From a total of 358,378 individual-level transplants, we obtained 1050 state-year level observations with 50 observations per year from 1988, when OPTN began collecting data, through 2008.[13] Note that our data counts are transplants: we only count the organs actually used for transplantation, not organs recovered or donors consenting. However, because our main focus is on living donors, the number of organs recovered and the number of organs transplanted is the same.

Fig. 1A and B describe how the volume and composition of organ donations have changed over time. Kidneys are the most common organ transplanted, followed by livers. Together these account for most of the organs transplanted in the U.S. and over 99% of all living donor organs. Kidney, liver and bone marrow donations generally increased until the late 2000s. This pattern, however, is much stronger for kidneys vis-à-vis livers and bone marrow. An overall upward trend in donations by both cadaveric and living donors exists until the late 2000s. Cadaveric donations far exceed those from living donors and underscore how infrequently compatible living donors come forward, although every human is born with two kidneys and a liver that can lose up to 70% of its size and still re-grow.

The highly detailed organ data include many variables associated with the medical procedure and demographics of both the transplant recipient and the donor. Table 2 reports summary statistics. On average, cadaveric donations dominate living donations with kidneys being the more common organ donated relative to livers. Males donate more organs overall, but this is due to more males donating cadaveric organs, while females dominate living donation. A variety of explanations could exist – men are more likely to die in accidents and tend to die earlier. Women may have more flexible work lives and might simply be more altruistic regarding live donation or more cautious about opting in to cadaveric organ donation. For livers, almost 94% of transplant recipients receive a cadaveric donor organ, while for kidneys about 30% receive a living donor organ. These differences suggest that we should break down our main analyses by both gender and organ. We also have information on the donor-recipient relationship. Seventy-two percent of live donors are biologically related to the transplant recipient. This likely arises in part due to donor-recipient capability issues, which mean family members are more likely to match the recipient's blood type and other match factors than a random person from the general population. Approximately 18% of living donors are not spouses and are biologically unrelated.

[11] This may be a lower bound since UNOS does not track information on all deaths. Gortmaker et al. (1996) estimated an eligible donor pool of 13,700 per year based on a study of 69 acute care hospitals in the U.S.

[12] www.transplantliving.org/livingdonation/outcomes/risks.aspx., accessed 03/26/12.

[13] For the regressions that analyzed organ quality changes, non-reporting of covariates leads to a reduction in observations. In the quality regressions using six-month and three-year survival rates as the outcome variable, the panel is shortened to give all recipients sufficient follow-up time.

Table 1A
State laws for organ donors. This table reports the year of introduction of the different laws analyzed in this study in the states where at least one of these laws was enacted, with reference to organ donations. The following states have none of the laws: AL, AZ, FL, KY, MI, MT, NE, NV, NH, NJ, SD, TN, VT, WY.

State	Leave for state employees	Leave for private employees	Tax deduction for individuals*	Tax credit for employers
Alaska	2008			
Arkansas	2003	2005	2005	2005
California	2002			
Colorado	1989			
Connecticut	2007	2004		
Delaware	2001			
Georgia	2002		2004	
Hawaii	2005			
Idaho	2006		2006	
Illinois	2002	2005		
Indiana	2002			
Iowa	2003		2005	
Kansas	2001			
Louisiana			2005	
Maine	2002	2002		
Maryland	2000			
Massachusetts	2005			
Minnesota	2006		2005	
Mississippi	2004	2004	2006	
Missouri	2001			
New Mexico	2007		2005	
New York	2001		2006	
North Carolina				
North Dakota	2005		2005	
Ohio	2001		2007	
Oklahoma	2002		2008	
Oregon				1991
Pennsylvania		2006		2006
Rhode Island			2009	
South Carolina	2002	2006		
Texas	2003			
Utah	2002		2005	
Virginia	2001		2007	
Washington	2002			
West Virginia	2005			
Wisconsin	2000		2004	

*Idaho has an individual tax credit rather than tax deduction.

3.2. Bone marrow

Bone marrow donation data were obtained from the National Marrow Donor Program (NMDP), the largest bone marrow registry in the U.S. The 14,463 transplants in our data do not include approximately 30% of the total donations recorded by NMDP. These donations were made by members of the military and by donors for whom no state of residence was recorded. Table 3 contains descriptive statistics for bone marrow donations. Both males and females donate at equal rates. Apheresis is a less common type of donation, largely due to its later uptake. Our data document no apheresis donations prior to 1999. In 2009, 0.7 apheresis donations occurred along with 0.3 aspiration donations, per one million individuals.

3.3. Legislation

The legislative data are compiled from donor program websites (www.optn.org and www.ncls.org), state government websites, and searches of state laws via Nexis®. We categorize the leave incentives into leave for employees of the state government ("state employees") and leave for private sector employees ("private employees"). Taxes fall into two categories: individual tax deductions of up to $10,000 or employer tax credits for donation-related expenses including promotional activities and paid leave for donation.[14]

[14] Virginia does not set a maximum and Idaho allows for a tax *credit* of up to $5,000.

4. Empirical strategy

Our empirical strategy exploits the fact that different states introduced legislation in different years; we use variation both across and within states over time to identify the effect of the legislation on a series of outcomes of interest. We estimate a linear model as follows[15]:

$$Y_{kt} = \mathrm{LEAVE}_{kt}{'}\delta_{leave} + \mathrm{TAX}_{kt}{'}\delta_{tax} + \mathrm{X}_{kt}{'}\beta + \theta_k + \eta_t + \tilde{a}_{kt} + \varepsilon_{kt} \quad (1)$$

In Eq. (1), Y_{kt} is the outcome variable in state k in year t, and we consider three main outcome variables: the number of organ donors standardized by one million population, the number of bone marrow donations per one million population, and post-organ transplant survival rates.[16] $LEAVE_{kt}$ and TAX_{kt} are indicators for

[15] In the online Appendix (Table A6 for organs and A9 for bone marrow) we also report the estimates from different specifications: a model where the outcome variable is the number of donations (count variable); a log-linear model where the outcome variables are entered in natural logarithm (plus 1); and fixed effect Poisson model (considering the discrete, non-negative nature of our outcome variables). The results are very similar to those from the models reported here. Online Appendix Figures A1 and A2 offer comparisons of specifications.

[16] We use the state of the donor and not of the transplant, i.e., our outcome is the number of donations that resulted in transplants per million individuals in a state regardless of whether any of those transplants occurred in that state. We do so because the legislation benefits residents of the state, but do not specify that an individual must donate in the state where he/she lives in order to enjoy the benefits. Using the state where the transplant took place would have been problematic because a given transplant center might perform transplants of organs originating in different states potentially with different legislation, which would have

Table 1B
State laws for bone marrow donors. This table reports the year of introduction of the different laws analyzed in this study in the states where at least one of these laws was enacted, with reference to bone marrow donations. The following states have none of the laws: AL, AZ, FL, KY, ME, MI, MT, NV, NH, NJ, NC, SD, TN, VT, WY.

State	Leave for state employees	Leave for private employees	Tax deduction for individuals[a]	Tax credit for employers
Alaska	2008			
Arkansas	2003	2005	2005	2005
California	2002			
Colorado	1989			
Connecticut	2004	2004		
Delaware	2001			
Georgia	2002		2004	
Hawaii	2005			
Idaho	2006		2006	
Illinois	2002	2005		
Indiana	2002			
Iowa	2003		2005	
Kansas	2001			
Louisiana	1992	1992		1992
Maryland	2000			
Massachusetts	2005			
Minnesota	1990	2004	2005	
Mississippi	2004	2004	2006	
Missouri	2001			
Nebraska	1992	1992		
New Mexico	2007		2005	
New York	2001	2007	2006	
North Dakota	2005		2005	
Ohio	2001		2007	
Oklahoma	2002		2008	
Oregon	1991	2002		1991
Pennsylvania		2006		2006
Rhode Island			2009	
South Carolina	2002	2002		
Texas	2003			
Utah	2002		2005	
Virginia	2001		1997	
Washington	2002			
West Virginia	2005			
Wisconsin	2000		2004	

[a] Idaho has an individual tax credit rather than tax deduction.

Table 2
Descriptive statistics – Organ transplants per one million population. Data are from OPTN and cover the period from 1/1/1988 through 12/31/2008.

Variable	State-year observations	Mean	Standard deviation	Minimum	Maximum
Total	1050	66.5	19.2	13.0	138.4
Live	1050	16.7	8.4	0.0	59.2
Cadaveric	1050	49.8	14.9	12.0	116.2
Male	1050	37.3	11.6	0.0	88.1
Female	1050	29.1	10.0	0.0	76.9
Livers	1050	16.0	6.1	0.0	45.1
Kidneys	1050	46.5	12.4	13.0	99.4
Live – male	1050	7.1	3.8	0.0	32.7
Dead – male	1050	30.3	10.1	0.0	78.1
Live – female	1050	9.6	5.1	0.0	36.1
Dead – female	1050	19.5	7.1	0.0	55.1
Live – Livers	1050	0.6	0.9	0.0	6.1
Dead – Livers	1050	15.4	5.9	0.0	44.4
Live – Kidneys	1050	16.1	7.9	0.0	59.2
Dead – Kidneys	1050	30.4	8.3	10.9	70.1

Table 3
Descriptive statistics – Bone marrow. The data for this table come from the NMDP and cover the period from 1/1/1987 through 12/31/2009.

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
Bone marrow transplants per 1 m population					
Total	1150	3.6	3.3	0.0	21.3
Female	1150	1.6	1.6	0.0	13.7
Male	1150	2.0	2.0	0.0	15.2
Apheresis versus aspiration per 1 m population					
Apheresis	1029	2.3	3.3	0.0	22.7
Aspiration	1029	3.7	2.9	0.0	33.0

contaminated the results. Moreover, not all states have a transplant center; for example, Alaska and Idaho have laws encouraging organ donation but do not have a transplant center. We thank an anonymous referee for prompting us to clarify this

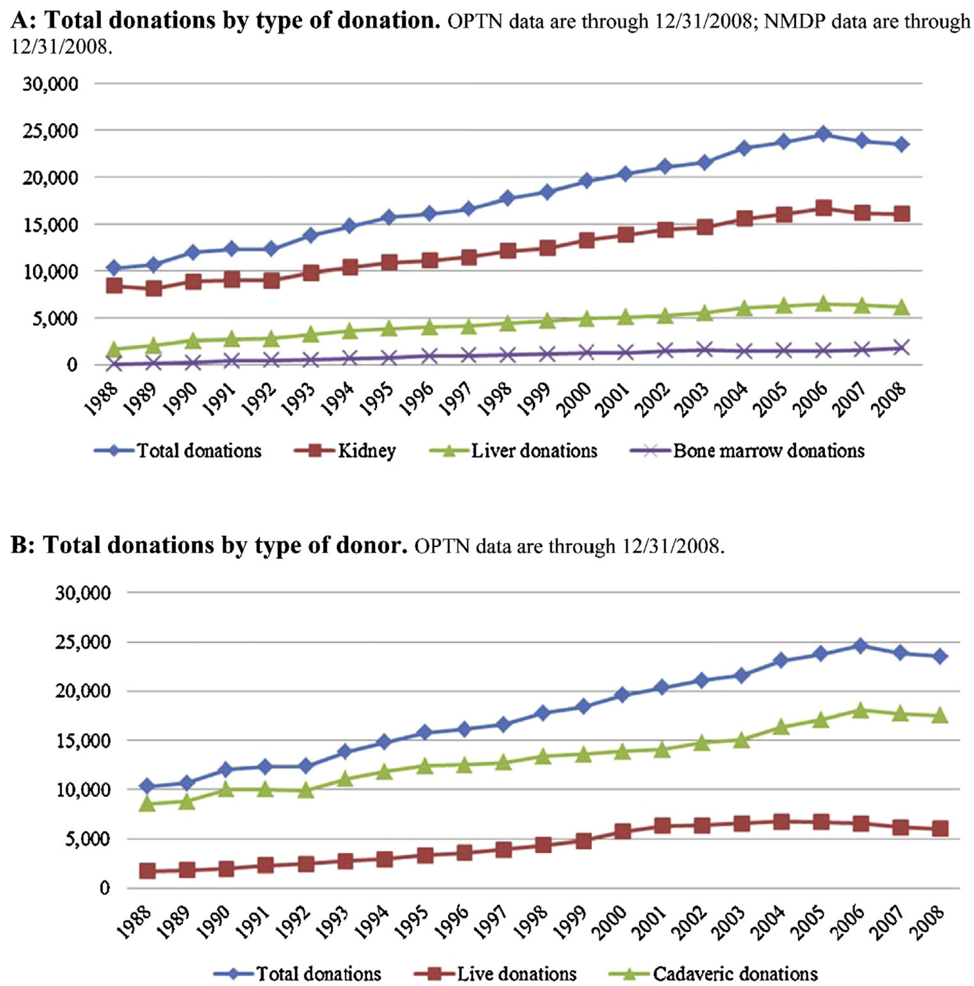

Fig. 1. Donations by year. A: Total donations by type of donation. B: Total donations by type of donor.

whether state k had leave legislation or tax legislation in place, respectively, in year t. More specifically, we include indicators for whether a state has leave provisions for state employees, leave provisions for private employees, tax deductions for individuals, and/or tax credits for employers. The vector of controls X_{kt} includes state-level income per capita and the unemployment rate, which could affect the availability and accessibility of transplant surgery. In the organ quality regressions, we also include donor, match, and patient characteristics to control for the differences in the types of donors, matches, and patients across states. Year fixed effects (η_t) account for aggregate factors that might affect the outcome variables, including nation-wide policy changes as well as secular trends in attitudes toward organ and marrow donation. θ_k are state fixed effects, γ_{kt} are state-specific time trends, and ε_{kt} is an error term. The main coefficients of interest, δ_{leave} and δ_{tax}, measure the within-state effect of passing a given type of legislation on the number of donations per million population, controlling for factors affecting all states in a given year, and state-specific fixed effects and time trends. In all regressions, standard errors are clustered at the state level to account for serial or other forms of correlation in the state law indicators (Bertrand et al., 2004).

Not all states have introduced such laws and different states have introduced the legislation at different times. This raises the question of whether adoption of these laws and the timing of adoption are correlated with our outcomes of interest. For instance, states with systematically higher levels of organ donations per capita might be more likely to introduce the legislation, perhaps due to greater familiarity with donation in the population or the transplant community's outreach efforts. In that case, a positive coefficient on the tax indicators might simply reflect this underlying heterogeneity rather than an effect of the law. The opposite is also possible; in other words, states with lower levels of organ or bone marrow donations per capita may be more likely to adopt the legislation in response to a shortage of organs. That case would bias our coefficient estimates downward. The inclusion of state fixed effects mitigates the bias that would occur if states adopted legislation based on the level of the outcome variable. Further, we include state-specific time trends to account for the possibility that states with systematically lower or higher growth rates of the outcome variable might be more likely to adopt the legislation.

To probe our identification strategy, we checked whether the passage of the legislation in a given state-year correlates with the lagged (one year) cumulative number of waitlist candidates per one million population; the lagged number of waitlist candidates year per one million population; the lagged cumulative number of individuals who ever left the waitlist dead or too sick for a transplant and the lagged number of waitlist candidates who died or were too sick for transplant, per one million population. We use these variables to proxy for lagged values of cumulative demand, current demand, cumulative excess demand, and current excess demand. We regress a dummy variable equal to one if a law was passed in the current year on lagged values (from the prior year) of these

Table 4
Probability of legislation passing. This table reports linear probability regression estimates of the probability of a given law passing. The data include the full unbalanced panel. State-level controls include unemployment rate and income per capita. All regressions include state and year fixed effects and state time trends. State-level clustered standard errors are in parentheses. ***$p < .01$, **$p < .05$, * $p < .1$.

Outcome = probability of law passing	(1) Leave for state employees	(2) Leave for private employees	(3) Tax deductions for individuals	(4) Tax credits for employers
Cumulative waitlist per 1 m population (prior year)	−0.014 (0.027)	0.006 (0.001)	−0.003 (0.019)	−0.004 (0.009)
Observations	1000	1000	1000	1000
R-squared	0.12	0.12	0.15	0.14
Cumulative waitlist per 1 m population minus cumulative removals from waitlist per 1 m population since 1988 (prior year)	0.068 (0.092)	−0.031 (0.035)	0.086* (0.051)	0.009 (0.030)
Observations	1000	1000	1000	1000
R-squared	0.12	0.12	0.15	0.14
Yearly number of candidates dying on the waitlist or deteriorating until too sick for transplant per 1 m population (prior year)	−0.189 (0.335)	0.086 (0.148)	0.282 (0.199)	0.019 (0.065)
Observations	1000	1000	1000	1000
R-squared	0.12	0.12	0.15	0.14
Cumulative candidates dying on waitlist or deteriorating until too sick for transplant per 1 m population (prior year)	−0.163 (0.127)	0.028 (0.020)	−0.0252 (0.079)	−0.0053 (0.034)
Observations	1000	1000	1000	1000
R-squared	0.12	0.12	0.15	0.14

waitlist variables, and report the results in Table 4. The estimated coefficients are generally small and not statistically significant, indicating that prior values of these variables did not generally have any discernible effect on whether a state passed a law. (specifications where we used two- or three-year lags yield similar results.) These results, together with the inclusion of year and state effects and state-level time trends in the regressions, support the validity of our identification strategy.

5. Results

5.1. Organ donations

We first estimate model (1) using total organ transplants per one million individuals in a given state and year as the dependent variable in columns [1] through [5] of Table 5, and living and cadaveric donor transplants separately in columns [6] and [7]. Although the tax and leave legislation generally target living donors, we consider donations from both living and deceased donors for two main reasons. First, one could postulate that donations from living and deceased donors follow a common time trend, and precisely because the legislation targets living donations, the donations by deceased donors might be seen as a benchmark, or "control" group. The second reason to study the effects on both living and deceased donations is that these types of donations might actually be substitutes, in which case donations from deceased donors could not be used as a control because under this hypothesis they would be affected by the legislation. For example, the waitlist only applies to potential recipients of cadaveric organs. If more living organs are donated, these individuals will drop from the waitlist, which might enable the donor-recipient matching process to be more selective as to which cadaveric organs are used in transplantation.[17]

Additionally, the employer tax credits could (in some states) apply to expenses incurred in promoting cadaveric donation as well as living donation. For these reasons, it is informative to study the effect of the legislation on both types of donations separately.

The results shown in column [1], which do not control for state or year effects, indicate a positive correlation between the number of transplants and the existence of leave for state employees and leave for private sector employees; however, the coefficient estimates dramatically drop in magnitude and statistical significance when year and state fixed effects are introduced in the specification. In column [5] we also add state-specific linear time trends, and again all of the coefficients of interest are estimated to be small and not statistically significant. These results underscore the importance of accounting for state-level heterogeneity and aggregate time effects. Specifically, it appears that the positive estimated coefficients on the legislation indicators in column [1] are reflecting a general trend of increasing donations over time. Breaking down the analysis by live and cadaveric donations in columns [6] and [7] does not change the main results.[18]

[17] Organs vary in quality, so without an increase in the number of transplants, an increase in the number of living donors should lead to a smaller group of individuals accessing the same pool of cadaveric donor organs, thus allowing only the highest quality organs to be selected. Donor factors correlated with lower survival outcomes after liver transplantation include donors over 40 years old, donation after cardiac death rather than brain death, partial rather than whole liver grafts, African-American race, shorter donors, and cerebrovascular causes of death (Feng et al., 2006). For kidneys, donor characteristics associated with poorer transplant outcomes include age, cerebrovascular causes of death, renal insufficiency (serum creatinine over 1.5 mg/dL) and a history of hypertension (Port et al., 2002).

[18] We performed a number of additional analyses to probe the (null) results on organs, and report them in the online Appendix: (1) We considered the possibility that effects may differ for men and women due in part to men's greater attachment to the workforce, the target of the tax and, especially, the leave legislation (Table A2); (2) We differentiated between kidneys and livers (Table A3); (3) We run the regressions on the number of donors who are biologically related, and on the number of donors who are not biologically related (both including and excluding spouses). The vast majority of organ donations occurs between biologically related individuals or between spouses, and one could imagine that leave and tax incentives might have a stronger impact on non-related potential donors (Tables A4 and A5). All of these additional analyses confirm our initial finding of no effect from the passage of the

Table 5
Organs – Baseline results. This table reports the regression estimates on the effects of the laws on organ transplants (per one million individuals). The data include the full unbalanced panel. State-level controls include unemployment rate and income per capita. State-level clustered standard errors in parentheses. ***$p < .01$, **$p < .05$, *$p < .1$.

Type of donations	(1) All	(2) All	(3) All	(4) All	(5) All	(6) Cadaveric	(7) Live
Leave for state employees	12.05***	−0.16	6.23***	0.02	−1.45	−1.71	0.26
	(3.64)	(2.76)	(2.15)	(1.80)	(2.25)	(1.94)	(1.02)
Leave for private employees	9.2	1.84	9.76*	5.97	6.85	8.17	-1.31
	(5.75)	(5.52)	(5.64)	(4.58)	(6.66)	(6.76)	(1.46)
Tax credits for employers	6.19	−3.04	1.54	−0.66	1.11	2.03	−0.92
	(5.29)	(4.29)	(3.78)	(5.29)	(5.92)	(6.61)	(1.03)
Tax deductions for individuals	10.72**	2.14	−1.41	0.47	−0.33	1.49	−1.82
	(4.84)	(4.45)	(4.23)	(2.58)	(3.79)	(3.49)	(1.34)
Year fixed effects		X		X	X	X	X
State fixed effects			X	X	X	X	X
State-year fixed effects					X	X	X
Observations	1050	1050	1050	1050	1050	1050	1050
R-squared	0.19	0.48	0.57	0.71	0.75	0.64	0.84

Table 6
Organs – Results controlling for and interacting with state employment rate. This table reports the regression estimates on the effects of the laws on organ transplants (per one million individuals). The specifications here add variables with information on the share of state employees (overall and full time) over the whole labor force. The data include the full unbalanced panel. State-level controls include unemployment rate and income per capita. All regressions include state and year fixed effects and state time trends. State-level clustered standard errors in parentheses. ***$p < .01$, **$p < .05$, *$p < .1$.

Type of donor	(1) All	(2) All	(3) Live	(4) Live	(5) Cadaveric	(6) Cadaveric
Leave for state employees	−6.37	−7.64	1.85	1.62	−8.23	−9.26*
	(5.61)	(5.64)	(3.51)	(3.10)	(4.75)	(4.92)
Leave for private employees	7.09	7.29	−1.33	−1.23	8.42	8.52
	(6.72)	(6.73)	(1.42)	(1.43)	(6.82)	(6.86)
Tax credits for employers	1.22	1.26	−0.85	−0.82	2.07	2.08
	(5.76)	(5.52)	(1.01)	(1.02)	(6.39)	(6.15)
Tax deductions for individuals	−0.53	−0.17	−1.78	−1.81	1.25	1.63
	(3.72)	(3.83)	(1.30)	(1.32)	(3.40)	(3.48)
State employees/labor force	1.52		0.21		1.31	
	(2.07)		(0.92)		(2.23)	
Leave for state employees* (state employees/labor force)	1.13		−0.36		1.49	
	(1.48)		(0.88)		(1.18)	
Full-time state employees/labor force		5.08		0.70		4.38
		(3.06)		(1.32)		(3.46)
Leave for state employees*(full-time state employees/labor force)		1.97		−0.43		2.41
		(2.04)		(1.08)		(1.70)
Observations	1050	1050	1050	1050	1050	1050
R-squared	0.75	0.75	0.84	0.84	0.64	0.64

In the case of leave for state employees, we also analyze the possibility that the population of state employees must be of a certain minimum size in order for the leave laws to have an effect on the number of donors. To this aim, we run our main regressions controlling for the number of state employees, both total and full-time, normalized by the total labor force at the state-year level (to parallel the construction of the left-hand side variable), and interact this variable with the law indicator. We report the results in Table 6. The estimated interaction effects are again small in magnitude and not statistically significant, confirming our previous finding that the legislation did not significantly affect organ donations.

legislation. In analyses not reported, we performed our tests using a balanced panel that includes only five years before passage of any tax or leave legislation and five years after the passage of that first legislation (omitting the year of introduction of the legislation), to reduce the influence of the long lags, in most cases, before the passage of legislation. We also increased the frequency of the observations to months and quarters and manipulated the length of the balanced panel. Lastly, we also tested whether the generosity of leave provisions might be important. None of these other approaches significantly altered our results. In all cases, we obtained a null result.

5.2. Bone marrow donations

As described in Section 2.2, many states have passed legislation for bone marrow donors that is separate from that for organ donors, but the legislation is similar in spirit. The primary difference is that leave allowances tend to be shorter for bone marrow donors. Additionally, while the legislation regarding organs does not present much variation in the generosity of the provisions across states, considerable variation exists in the laws providing leave for state employees to donate bone marrow as shown in Table 7. Twelve states provide leave of less than one week and nineteen states provide leave of greater than or equal to one week. Three states

Table 7
Generosity of leave for state employees – number of states.

Leave for state employees to donate	Organs	Bone marrow
2 days paid	1	1
5 days paid	2	11
7 days paid	0	13
10 days paid	1	1
20 days paid	2	2
30 days paid	23	3
Unpaid leave	3	3
Total	32	34

Table 8
Bone marrow – Baseline results. This table reports the regression estimates on the effects of the laws on bone marrow donations (per one million individuals). The data include the full unbalanced panel. State-level clustered standard errors are in parentheses. *** $p<.01$, ** $p<.05$, * $p<.1$.

	(1)	(2)	(3)	(4)	(5)
Leave – state	0.80*	−0.72	−0.01	−0.82*	0.11
	(0.44)	(0.61)	(0.46)	(0.48)	(0.41)
Leave – private	−0.45	−0.96*	−0.65	−0.82	0.24
	(0.37)	(0.57)	(0.47)	(0.53)	(0.49)
Tax – employer	−0.15	−0.03	0.13	0.12	0.79
	(0.56)	(0.81)	(0.68)	(0.55)	(0.79)
Tax – individual	0.01	−0.99*	−1.19*	−0.88*	−0.13
	(0.35)	(0.51)	(0.48)	(0.44)	(0.42)
Year fixed effects		X		X	X
State fixed effects			X	X	X
State-year fixed effects					X
Observations	1150	1150	1150	1150	1150
R-squared	0.19	0.43	0.53	0.66	0.79

provide unpaid leave. This cross-state variation allows us to probe whether the effect of the laws, if any, is stronger when the size of the benefit is bigger.

The results are presented in Tables 8 through 10. Once again, in the most conservative specification reported in Table 8 (including year and state fixed effects and state time trends) we find no evidence that leave or tax legislation had any impact on the number of bone marrow donations (normalized by one million population). In Table 9, we check whether the burden to the donor in terms of pain and suffering is important for these laws to have an effect. As described earlier, apheresis is less burdensome to the donor than aspiration in terms of pain and suffering and potentially time away from work. Although the generosity of the leave provisions does affect donation, the results from Table 9 indicate that the burden of the procedure itself does not appear to impact the decision of the marginal donor.

Once we control for the size of the state employees population (normalized by the state labor force to parallel the way we constructed the outcome variable), however, we find that the laws providing leave for state employees have a positive effect on the number of bone marrow donors per one million population, provided that the share of state employees – i.e., the beneficiaries of the legislation – is sufficiently large. In column [1] of Table 10, the interaction term between the law providing leave for state employees and the rate of state employment has a positive, statistically significant coefficient. The point estimates of about −1.5 on leave for state employees (marginally significant) and of 0.39 on the interaction term (significant at the 5% level) imply that leave for state employees has a positive effect if state employees represent about 4% of the labor force, which is true for roughly half of the state-year observations in the data. The point estimates imply positive effects statistically significant at the 10% confidence level for state employment percentages one standard deviation above the mean,[19] and significant at the 5% level for state employment percentages two standard deviations higher than the mean, and negative effects that are never statistically significant (not even marginally) for state employment rates within the sample. In column [2], we use the rate of full-time employees (which account for 72% of state employees), and the regressions yields very similar results: the effect of leave legislation on bone marrow donations is positive if full-time state employees are at least 2.9% of the state labor force, which again holds for about half of state-year observations in the sample.

Columns [3] through [6] explore the importance of the generosity of leave. We split the leave for state employees variable into three categories: leave of less than one week, leave of greater than one week, and no leave for state employees (the omitted category). The National Marrow Donor Program reports that marrow donors should “be able to return to work, school and any other activities within one to seven days,” (NMDP, 2013). In other words, although a donor might not need a full seven days to recover, the donor might be more hesitant to donate in a state in which the maximum allowed leave is less than the higher end of the expected recovery period. As shown in columns [3] and [4], only leave of greater than or equal to one week has a positive impact on the number of bone marrow donors per one million population. Again, the effect is stronger for full-time employees.

In columns [5] and [6] we test the importance of paid leave and further corroborate our results that incentive size matters for promoting donation. The coefficients on the interaction terms are larger and more statistically significant than when we included unpaid leave in our leave for state employees variables, but again, the positive effect only exists for leave of greater than or equal to one week.

Table 9
Bone marrow – Donations by method. This table reports the regression estimates on the effects of the laws on bone marrow donations (per one million individuals), by method of donation. The data include the unbalanced panel limited to the state-years in which apheresis donations were recorded (i.e., post 1998). All regressions include state and year fixed effects and state time trends. State-level clustered standard errors are in parentheses. ***$p<.01$, **$p<.05$, *$p<.1$.

	(1) Apheresis donations	(2) Aspiration donations
Leave for state employees	−0.20	0.29
	(0.42)	(0.34)
Leave for private employees	0.42	−0.63**
	(0.36)	(0.29)
Tax credits for employers	1.27**	0.43
	(0.59)	(0.39)
Tax deductions for individuals	−0.68	0.29
	(0.67)	(0.53)
Observations	547	547
R-squared	0.86	0.81

5.3. *Effect on the quality of organs*

Although we found no effect of these types of legislation on the quantity of organ donation, we explore the possibility that these laws could have shifted the *quality* composition of organs

[19] On average across all state-year observations, state employees represent 4.3% of the labor force (standard deviation = 1.5). The lowest rate observed in the sample is 2.3% and the maximum is 11.8%. Full-time state employees are 3.2% of the labor force on average (standard deviation = 1.2), the lowest rate is 1.6% and the highest 8.6%.

Table 10
Bone marrow – Results controlling for and interacting with state employment rate. This table reports the regression estimates on the effects of the laws on bone marrow donations (per one million individuals). The specifications here add variables with information on the share of state employees (overall and full time) over the whole labor force. The data include the full unbalanced panel. State-level controls include unemployment rate and income per capita. All regressions include state and year fixed effects and state time trends. State-level clustered standard errors in parentheses. ***$p < .01$, **$p < .05$, *$p < .1$.

	(1)	(2)	(3)	(4)	(5)	(6)
Type of leave for state employees	Any	Any	Any	Any	Paid	Paid
Leave for state employees	−1.54*	−1.44*				
	(0.83)	(0.75)				
Leave for state employees < one week			0.96	1.41	0.96	1.44
			(2.27)	(2.53)	(2.28)	(2.55)
Leave for state employees > = one week			−1.58**	−1.51**	−2.17***	−2.00***
			(0.79)	(0.71)	(0.72)	(0.65)
Leave for private employees	0.18	0.1	0.18	0.17	0.19	0.18
	(0.53)	(0.52)	(0.49)	(0.48)	(0.53)	(0.53)
Tax credits for employers	0.75	0.77	0.78	0.74	0.78	0.73
	(0.87)	(0.85)	(0.95)	(0.93)	(0.97)	(0.95)
Tax deductions for individuals	−0.23	−0.18	−0.19	−0.18	−0.23	−0.2
	(0.42)	(0.40)	(0.39)	(0.39)	(0.39)	(0.39)
State employees/labor force	−0.22		−0.23		−0.22	
	(0.34)		(0.34)		(0.34)	
Leave for state employees*(state employees/labor force)	0.39**					
	(0.18)					
Full-time state employees/labor force		−0.54		−0.56		−0.56
		(0.45)		(0.44)		(0.44)
Leave for state employees*(full-time state employees/labor force)		0.50**				
		(0.23)				
Leave for state employees < one week*(state employees/labor force)			−0.36		−0.36	
			(0.59)		(0.59)	
Leave for state employees > = one week*(state employees/labor force)			0.41**		0.53***	
			(0.18)		(0.15)	
Leave for state employees < one week*(full-time state employees/labor force)				−0.71		−0.72
				(0.96)		(0.97)
Leave for state employees > = one week*(full-time state employees/labor force)				0.54**		0.67***
				(0.23)		(0.19)
Observations	1150	1150	1150	1150	1150	1150
R-squared	0.79	0.79	0.79	0.79	0.79	0.79

used for transplant.[20] One way this could happen is if the legislation has opposed effects on different types of living donors. For example, the laws might have led to increased donations among less intrinsically motivated donors and decreased them among the more intrinsically motivated and the latter are donors of higher "quality," on average (Titmuss, 1971).[21] Another possibility is that the laws are affecting living and deceased donations differently. Fernandez et al. (2013) measure a substitution effect between live and cadaveric donors. A shift in the distribution of donors between living and cadaveric could also lead to a shift in the quality distribution if those two donor sources lead to systematically different survival outcomes. Both medical and social factors could lead to differences in the outcomes yielded by these two donor sources. Although living donors do tend to be older and, therefore, less likely to yield high-quality organs, the timing of donation can be optimized with living donors. The timing is important for two reasons: one, because organs rapidly deteriorate without a blood supply, and two, because live donation ensures that the recipient and donor are in the best health possible at the time of transplantation. With cadaveric donation the timing of the transplant is entirely determined by the time of death of the donor. Regarding social factors, living donation may proxy for a better social support network, which could improve longer term survival.[22]

We consider two measures of the quality of the organ transplanted, the total number of grafts functioning for at least six months and for at least three years as a share of the total number of transplants. Tables 11 and 12 show descriptive statistics for the quality outcome variables. In all of our regressions, we include a range of match, donor, and recipient characteristics that could affect survival.[23] Obviously, longer time periods are associated with higher death rates. Table 12 also shows that the means survival rates for recipients of living donations are higher than for recipients of cadaveric donor organs.

The regression results in Table 13 (from a linear probability model) show, overall, no effect of these laws on the quality of the organs donated as measured by the six-month state-level survival rate. For the three-year survival period, however, we find an overall (i.e., in column 4, where we consider all types of donations) positive effect from leave for state employees and tax credits for employers, although the estimated coefficients are only marginally statistically significant. We also find a negative effect on three-year

[20] Because survival data are not available for bone marrow transplants, we must limit the quality analysis to just organ donation.

[21] Note that the opposite could also happen, with the more intrinsically motivated donors being lower-quality donors (Healy, 2006). If these donors have lower motivation to give in the presence of incentives, the quality of the resulting pool of organs will actually increase.

[22] n a study of 289 transplant centers, the lack of a support person available to the transplant recipient was viewed as an absolute contraindication to transplantation by 6.5% and 2.6% of kidney and liver transplant centers, respectively. The relative contraindication percentages are 67.4% and 33.5% for kidneys and livers, respectively (Levenson and Olbrisch, 1993). Although we are unaware of any studies directly testing the effect of social networks on post-transplant survival among liver and kidney recipients, authors have documented its importance in heart transplantation (Bohachick et al., 2002) and long-term dialysis outcomes (Thong et al., 2007). A review of 122 studies across medical fields suggests that social support is important for patient adherence to medical treatment (DiMatteo, 2004). Conversations with personnel at the University of Michigan's transplant center also strongly confirm a strong social support network as crucial for long-term post-transplant survival.

[23] The controls used mirror those used by the Scientific Registry of Transplant Recipients to calculate transplant-center-level expected survival rates and include age, gender, race, live donor, pediatric recipient, and underlying diagnosis.

Table 11
Descriptive statistics – donor, match, and patient characteristics. The percentages and averages in this table are calculated for the whole sample. Subsample rates are used in subsample analyses.

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
Incompatible recipient-donor blood types (%)	1050	15%	12%	0%	68%
Pediatric patients (<18 years) (%)	1050	8%	3%	0%	30%
Multi-organ recipients (%)	1050	2%	2%	0%	15%
With diabetes diagnosis (%)	1050	16%	5%	0%	38%
With non-cholestatic liver disease (%)	1050	55%	13%	0%	100%
Cold ischemia time	1050	13	3	6	26
Recipient age	1050	44	4	32	55
Days on waitlist	1050	393	130	55	880

Table 12
Descriptive statistics – quality outcome variables.

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
Survive six months – all donor types	1050	86%	7%	54%	100%
Survive three years – all donor types (%)	1050	62%	24%	0%	100%
Survive six months – live donors (%)	1047	93%	7%	0%	100%
Survive six months – cadaveric donors (%)	1050	84%	7%	44%	100%
Survive six months – female donors	1050	86%	8%	33%	100%
Survive six months – male donors (%)	1050	86%	7%	17%	100%
Survive six months – live female donors (%)	1042	92%	9%	0%	100%
% survive six months – cadaveric female donors	1048	83%	10%	0%	100%
Survive six months – live male donors (%)	1035	93%	10%	0%	100%
Survive six months – cadaveric male donors (%)	1050	85%	8%	0%	100%
Survive six months – kidney donors (%)	1050	89%	6%	55%	100%
Survive three years – kidney donors (%)	1050	65%	25%	0%	100%
Survive six months – live kidney donors (%)	1047	93%	7%	0%	100%
Survive six months – cadaveric kidney donors (%)	1050	87%	7%	43%	100%
Survive six months – liver donors (%)	1046	78%	11%	0%	100%
Survive three years – liver donors (%)	1046	56%	24%	0%	100%
Survive six months – live liver donors (%)	573	80%	30%	0%	100%
Survive six months – cadaveric liver donors (%)	1046	78%	11%	0%	100%

Table 13
Tax and leave effects on quality – all organs. The data in this table include the full unbalanced panel. All survival rates are multiplied by 100 so the coefficients can be read as percentage changes. All regressions include state and year fixed effects and state time trends. Case mix controls: recipient age, recipient gender, recipient race, diagnosis = noncholestatic v. other (livers), diagnosis = diabetes v. other (kidneys), live donor, and pediatric recipient. State-level clustered standard errors in parentheses. *** p<.01, ** p<.05, * p<.1.

	(1)	(2)	(3)	(4)	(5)	(6)
Survival time	Six months	Six months	Six months	Three years	Three years	Three years
Type of donor	All	Live	Cadaveric	All	Live	Cadaveric
Leave for state employees	−0.03	0.37	−0.14	1.32*	2.29	0.88
	(0.46)	(0.77)	(0.59)	(0.73)	(1.52)	(0.85)
Leave for private employees	−0.22	1.28	−0.12	−0.84	−4.34**	0.63
	(0.91)	(1.21)	(1.47)	(1.14)	(1.77)	(1.35)
Tax credits for employers	1.07	0.33	1.19	1.91*	8.22**	0.47
	(1.23)	(1.36)	(1.75)	(1.06)	(3.71)	(1.12)
Tax deductions for individuals	−0.31	1.04	−0.33	2.57	1.09	2.31
	(0.72)	(0.93)	(0.89)	(1.92)	(2.47)	(1.99)
Observations	1050	573	1046	950	946	950
R-squared	0.74	0.58	0.69	0.89	0.74	0.84

survival of recipients of organs from living donors and a positive effect on the same group from tax credits to employers (column 5).

In the online Appendix, the quality analysis is reported separately for kidneys and livers (Tables A10a and A10b). We find some marginally significant positive effects on six-month survival and a significant effect on three-year survival from tax credits for liver transplant recipients.

Thus, the legislation might be inducing quality improvements in survival rates by changing the composition of the donor pool even though it does not increase overall organ donations. Even though no systematic pattern emerges, these results do not support the hypothesis that incentives lead to a crowding out of high quality donors, at least for the relatively small incentives provided by the laws studied herein.

6. Discussion and Conclusions

Policymakers and scholars have long debated how to overcome the shortage of organs and bone marrow in the U.S. In systems based exclusively on altruistic donors, the supply is insufficient to cover the need, and legal rules and social norms prevent direct compensation. We analyzed tax and leave laws, which allow donors of organs or bone marrow to be, at least financially, not significantly worse off than before donating. Donating an organ or bone marrow is a costly decision for the living donor, and one that may hinge on financial (and work-related) considerations. Because of these costs, both financial and in terms of pain and suffering for the donor, the tax- and leave-related incentives may be insufficient to significantly lessen the discrepancy between supply and demand, i.e., the efficacy of these laws is certainly not guaranteed. However, if an effect is to be found, we anticipated that less costly types of donation, such as bone marrow, or more generous incentives, such as longer leave, would be associated with higher statistical significance and larger effects in our regression analysis.

Our results are consistent with this interpretation; we document no impact of the legislation on the number of organ donations, and a positive impact of leave for state employees on bone marrow donations when the population affected is sufficiently large. The positive effect on bone marrow donations is larger for more generous provisions, such as longer and paid leave. We also find some evidence suggesting that the legislation might affect the quality of the organs transplanted, even though no systematic patterns emerged. More research is needed, but this suggests that only focusing on changes in quantity may overlook shifts in the underlying quality distribution of organs used for transplantation.

A few explanations exist for the lack of an effect of the legislation on the quantity of organs. First, it is possible that not enough people are aware of the existence of the legislation. UNOS, for example, does not mention these types of legislation in its summary of information for prospective living organ donors (UNOS, 2013). The NMDP does, however, mention the existence of laws providing leave to donors, which also could help explain the stronger effect of these types of legislation on bone marrow donations (NMDP, 2013). Second, the results could be confounded by the existence of grant programs, which already may be providing the same cost reimbursement as the tax laws.[24] Employer-specific paid leave programs could further be obscuring the effects of legislation mandating leave for private employees.[25] Third, a compositional effect might be occurring, whereby some subsets of the population are positively motivated by these additional incentives to donate (on top of their intrinsic motives) whereas others are "crowded out" (because their self or social image may be tainted Benabou and Tirole, 2006 or because they consider the presence of material incentives repugnant: Benabou and Tirole, 2006; Roth, 2007). Fourth, the incentives put in place by these types of legislation might not be strong enough to induce an individual, who is not otherwise sufficiently altruistically motivated, to endure the pain, suffering, scarring, time away from work and leisure, and undocumented long-term donor health effects implied by an organ donation. Some evidence also exists that donors occasionally have difficulty obtaining life and health insurance post-donation (Rudow et al., 2006; Spital and Jacobs, 2002).[26] Untangling these explanations is of importance for policymakers interested in increasing and enhancing the supply of organs for transplantation and for the many individuals on the waitlist, who will die without a donor organ.

The positive effect of the legislation on bone marrow donations, and the fact that the effect was increasing in the generosity of the legislation, lead us to favor the fourth explanation: although tax breaks and leave provisions may be sufficient to induce, at the margin, individuals to undergo a moderately invasive procedure such as a bone marrow donation, they may be too low for the more "costly" organ donations. Similarly, there may be enough individuals at the margin between being willing to donate bone marrow or not, but this may not be the case for organs. In other words, and following the terminology of Gneezy and Rustichini (2000), the incentives described here may be "large enough" for bone marrow donations, but not for organ donations. The findings from Lacetera and Macis (2013) and Lacetera et al. (2011, 2012) of a positive effect of leave legislation and $5–15 gift cards on an even less invasive procedure, blood donation, are in line with our interpretation. If this interpretation is correct, then we would expect larger incentives to have positive effects on bone marrow donations and potentially also on organ donations. More systematic analyses from contexts where such stronger incentives are provided would be needed to reach firmer conclusions, however. The recent decision on December 1, 2011 by the 9th U.S. Circuit Court of Appeals that bone marrow apheresis can be compensated will provide researchers with an opportunity to further our understanding of which policies are effective in reducing the organ and bone marrow demand-supply imbalance.[27]

[24] For the particularly financially constrained, organizations such as The National Living Donor Assistance Center (www.livingdonorassistance.org) provide grants to cover the costs of donation, which may leave the legislation with little room to have an impact.

[25] The American Society of Transplantation publishes an incomplete list of the names of private companies offering their employees paid leave to donate (http://www.myast.org/sites/default/files/legacy_pdfs/public_policy/ELOD_Participating_Institutions.pdf).

[26] Perhaps suggestive of the issues with insuring organ donors, The Living Organ Donor Protection Act, which would have ensured donors could not be denied coverage or charged surcharges by health insurers, died in Committee. http://www.govtrack.us/congress/bills/111/hr1558.

[27] The apheresis technique did not exist at the time of the National Organ Transplant Act in 1984 (Korbling and Freireich, 2011). This highlights the importance of legislative evolution to match scientific innovation.

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