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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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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

In an attempt to alleviate the shortfall in organs and bone marrow available for transplants, many U.S. states 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 and passage of such legislation to analyze its impact on organ donations by living and deceased persons, on measures of the quality of the organs transplanted, and on the number of bone marrow donations. We find that these provisions did not have a significant impact on the quantity of organs donated. The leave legislation, however, did have a positive impact on bone marrow donations. We also find some evidence of a positive impact on the quality of organ transplants, measured by post-transplant survival rates. Our results suggest that these types of legislation work for moderately invasive procedures such as bone marrow donation, but may be too low for organ donation, which is riskier and more burdensome to the donor.

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An online appendix is available at:
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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, 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, 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 aversion or “repugnance” toward the commercialization of body parts have influenced the debate heavily (Frey, 1993; Roth, 2007; Titmuss, 1971). Some scholars and policymakers have manifested an aversion to any form of explicit reward for organ donors whereas others have advocated 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, to clear.² Others see direct cash payments as potentially deleterious or socially unacceptable, but are open to considering some form of “in-kind” rewards to help reduce the supply shortage of human organs and tissue (Frey, 1993; Lacetera and Macis, 2010, 2012; 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).³ Israel also allows some direct payments to donor families to “memorialize” 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

¹ These statistics are taken from the Organ Procurement and Transplantation Network (OPTN) for organs and from Bergstrom et al. (2009) for bone marrow.

² The only country without an organ supply shortage is Iran, where the sale of kidneys has been legal since 1988. The Iranian government pays \$1,200 and provides health insurance for one year to cover surgery-related conditions. In addition, the vendor receives between about \$2,300 and \$4,500 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).

³ New U.S. policies do provide priority for prior living donors on the transplant waitlist, effective 05/24/2012. http://optn.transplant.hrsa.gov/PoliciesandBylaws2/policies/pdfs/policy_172.pdf.

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 employees (and in some cases private 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 all 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.⁴ We also assess whether the impact of the legislation varies by gender and donor-recipient relationship. 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 two 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, Howard, and Stohr, 2012); if so, legislation targeting one type of donors might have effects on the other type as well. We also study whether these laws affect the distribution of 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.⁵

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 (Maddey 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).

⁴ The Organ Procurement and Transplantation Network. <http://optn.transplant.hrsa.gov/latestData/advancedData.asp>. Accessed 07/04/2012.

⁵ 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.

Our empirical strategy exploits the fact that different states have introduced legislation at different points in time, which provides us with several “natural experiments.” We take advantage of the longitudinal nature of our dataset to lessen potentially important selection, endogeneity, and omitted variable problems. 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 coefficient implies that leave legislation for state employees has a positive effect on bone marrow donations if state employees represent at least 5% of the labor force, which is the case for about 45% of our sample of state-years.

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 might be 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. The latter types of donors may be of higher “quality” (Titmuss, 1971); therefore, 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 although the estimated coefficients are only marginally statistically significant. We also find a positive effect of leave for private employees on six-month survival rates of recipients of organs from male donors and positive effects of individual tax credits on six-month survival rates of recipients of organs from female donors. 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.

Our study contributes to a small but growing literature in economics on organ and bone marrow donation. Two recent 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, Elder, and Moore, 2012; Fernandez, Howard and Stohr, 2012). Kessler and Roth (2012) studied the effect of priority rules in a laboratory experiment. 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, Garratt and Sheehan-Connor (2009 and 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), 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 similar but more limited studies exist. Venkataramani et al. (2012) examined the effect of tax deductions for individuals on living organ donation. Bilgel (2011) and Wellington and Sayre (2011) studied 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 addition to the types of legislation and donation considered by these papers, we analyze the effects of two similar types of legislation granting leave to private employees and tax credits to employers for donation-promoting activities. Boulware et al. (2008) included 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. We also explore whether these laws affected the quality of organs donated. Perhaps most importantly, our paper is the first to we examine the effects of these policies also 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. The positive effect we find on *bone marrow* donation, in addition to its relevance for policy and health consideration, 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. This is consistent with the positive effect found by Lacetera and Macis (2012) of paid leave on an even less invasive procedure, blood donation.⁶

⁶ Through utilizing the UNOS data request process rather than relying on 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

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 Background⁷

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 liver was not successfully transplanted until 1989.

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.⁸

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 1990.⁹ 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 expanding 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

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.

⁷ 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].)

⁸ <http://www.organtransplants.org/understanding/history/index.html>

⁹ Medicare approved liver transplantation for a limited number of conditions 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.

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 (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 hours and livers for up to 12 hours without a living blood supply. Despite over two million deaths in the U.S. in 2009, eligible deaths documented by UNOS totaled only 9,827.¹⁰ These deaths yielded organs used in 11,285 kidney transplants and 6,098 liver transplants, supplemented with 6,387 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 leave taken to donate. The health risk remains: for kidney donors 3.1 deaths per 10,000 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.¹¹

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

¹⁰ 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 sixty-nine acute care hospitals in the U.S.

¹¹ www.transplantliving.org/livingdonation/outcomes/risks.aspx, accessed 03/26/12.

cover donation-promoting activities, including the provision of paid leave to donors. Tables 1A (organs) and 1B (bone marrow) list the dates of passage for each type of legislation by state. (Legal references are listed in the appendix by state.) 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.¹²

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).¹³ From a total of 358,378 individual-level transplants, we obtained 1,071 state-year level observations with 51 observations per year from 1988, when OPTN began collecting data, through 2008.¹⁴ 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.

Figures 2A and 2B 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 of 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.

¹² Further details on the specifics of the laws are available at:

http://sitemaker.umich.edu/sarah.stith/files/lms_organodonation_onlineappendix.pdf.

¹³ “The data reported here have been supplied by the United Network for Organ Sharing as the contractor for the Organ Procurement and Transplantation Network. The interpretation and reporting of these data are the responsibility of the authors and in no way should be seen as an official policy of or interpretation by the OPTN or the U.S. Government.” (http://optn.transplant.hrsa.gov/shareddownloadables/data_use_agreement.pdf)

¹⁴ Total observations in the regressions considering livers only are lower because some state-years had no living donor transplants. 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.

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 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. Table 3 shows the distribution of transplants by type of donor-recipient relationship. Most 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.

3.2 Bone marrow

Bone marrow donation data were obtained from the National Marrow Donor Program (NMDP). We have a total of 14,463 transplants. The total number of donations omits approximately 30% of bone marrow donations by members of the military and for registrants for whom no state of residence was recorded.¹⁵ Table 4 contains descriptive statistics for bone marrow donations. The table reveals that 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. By 2009, 0.7 apheresis donations occurred along with 0.3 aspiration donations, per one million population.

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 (hereinafter “state employees”) and leave for private sector employees (hereinafter “private employees”). Taxes fall into two categories: individual tax deductions of

¹⁵ Although our organ data contain all organs transplanted, our bone marrow data are limited by the fact that only 36,800 of the total 54,140 requests for donations recorded include state-identifying information. Most omitted requests involve international and Department of Defense donors. Our outcome variables include only those 14,463 requests for donation that result in actual donation of bone marrow.

up to \$10,000 or employer tax credits for donation-related expenses including promotional activities and paid leave for donation.¹⁶

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. Specifically, we estimate a reduced-form model that takes the following form:

$$Y_{kt} = LEAVE_{kt}'\delta_{leave} + TAX_{kt}'\delta_{tax} + X_{kt}'\beta + \theta_k + \eta_t + \gamma_{kt} + \varepsilon_{kt}. \quad (1)$$

In Equation (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. $LEAVE_{kt}$ and TAX_{kt} are indicators for 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 correlation in the state law indicators (Bertrand et al., 2004).¹⁷

Not all states have introduced such laws and different states have introduced the legislation at different times. This raises the question of whether the adopting states differ from the non-adopting states in fundamental ways that 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

¹⁶ Virginia does not set a maximum and Idaho allows for a tax *credit* of up to \$5,000.

¹⁷ In addition to the specifications described above, we used logs and other nonlinear variations and/or normalizations of the outcome variables. We also increased the frequency of the observations to months and quarters and manipulated the length of the balanced panel. None of these other approaches significantly altered our results.

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 correlated 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 number of waitlist candidates who died or were too sick for transplant, per one million population; and the lagged cumulative number of individuals who ever left the waitlist dead or too sick for a transplant. We use these variables to proxy for lagged values of cumulative demand, current demand, cumulative excess demand, and current excess demand. Table 5 reports summary statistics for these variables. On average, seventy individuals per one million population were awaiting an organ in a given state-year and four individuals per one million population die on the waitlist or are deemed too sick for transplantation each year.¹⁸ 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 the waitlist variables in Table 5. As shown in Table 6, the estimated coefficients are generally small and not statistically significant (with only two exceptions where the coefficients are small and marginally significant), indicating that prior values of these variables did not generally have any discernible effect on whether a state passed a law.¹⁹ These results, together with our inclusion of year and state effects and state-level time trends in the regressions, make us confident about the validity of our identification strategy.

5. Results

5.1 Organ donations: Main results

We first estimate model (1) using total organ transplants per one million population as the dependent variable in columns [1] through [5] of Table 7A, and living and cadaveric donor transplants separately in columns [6] and [7]. Although the tax and leave legislation generally target living donors, we consider

¹⁸ The waitlist figure is larger for kidneys due primarily to better waitlist survival rates allowed for by dialysis. No similar life-extending pre-transplant therapy exists for end-stage liver disease.

¹⁹ Specifications where we used two- or three-year lags deliver similar results.

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.²⁰ 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 include 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 cease to be statistically significant when we introduce year and state fixed effects. In column [5] we add state-specific linear time trends, and again all of our 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, with the latter having the largest impact on our coefficient estimates of interest. Specifically, it would appear that the positive estimated coefficients on the legislation indicators in column [1] were 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. We also consider 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, and report the results in Table 7B. Again, we find no significant effects. Lastly, we differentiate between kidneys and livers in Table 7C. Here, too, we obtain estimated coefficients that are both small and statistically insignificant. The single exception, in the absence of more defined patterns in the data, should, more plausibly, be attributed to random chance.

²⁰ 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 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, less height, 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).

5.1.1 Organ donations: Additional analyses

We perform a number of further analyses to probe the (null) results described above.

Balanced Panel. First, our panel extends from 1/1/1988 to 12/31/2008. However, most of the legislation occurred around and after the year 2000. To reduce the influence of the long lags, in most cases, before the passage of legislation, we estimate model (1) using a panel including 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.²¹ Focusing on the period of time in which we can most confidently attribute differences in the number of live and cadaveric donors between states with and without legislation *to* the legislation, we still find no effect from the passage of these laws.²²

Related vs. Unrelated Donors. Second, as described in Table 3, the vast majority of organ donations occur between biologically related individuals or between spouses. One could imagine that although leave and tax incentives might not play a major role in the decision of potential donors who are biologically related to the recipient, they might have a stronger impact on non-related potential donors. In Table 8, we run our main 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). Our results indicate insignificant effects of leave for state employees and tax deductions for individuals. Tax credits for employers seem to have a negative effect on biologically related donors and a (marginally statistically significant) positive effect on donations from non-biologically related donors, but the point estimates are very small in magnitude. We also detect a negative effect of leave for private employees on donations by non-biologically related donors, but again the estimated effect is negligible in magnitude. The most prevalent laws (i.e. leave for state employees and tax deductions for individuals) do not seem to affect biologically related and non-biologically related donors differently. Therefore, we find only weak evidence for the hypothesis that non-biologically related donors are more sensitive to the financial disincentives to donation.

State employees as a share of the labor force. Third, we note that leave for state employees should only affect the incentives of state employees. We, therefore, re-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. These results are reported in Table 9. Even though the estimated interaction effects are not statistically significant, their positive sign and considerable magnitude suggest that perhaps the laws have some positive effect increasing with the size of the population affected by the law.

²¹ These results are available upon request.

²² The estimated coefficients on tax credits for employers (Appendix Table A1.4) are negative and statistically significant. We report these results for completeness, but note that they should be interpreted with great caution given the very small sample size of the balanced panel (only 30 observations).

5.2 Bone marrow donations: Main results

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 main difference is that leave allowances tend to be shorter for bone marrow donors. Because the bone marrow donation procedure is less costly to the donor relative to organ donation (in terms of risk of complications, pain and suffering, recovery time, and the possibility of future donation), such incremental measures as these laws might have a greater impact, at the margin, for bone marrow donors than they do for organ donors.²³ In addition, two methods of donation exist—apheresis and aspiration, with the former being a much less invasive procedure.

The results are presented in Tables 10A through 10C. Once again, in our most stringent specification (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). Given the evidence reported in Figures 2B and discussed in Section 4, including time trends is particularly relevant here.

If we break down donations by gender (Table 10B), we again find no effect from such laws. In Table 10C, we split our regressions between donations by apheresis versus donations by aspiration. Apheresis as a form of donation first appears in our data in 1999, so we run our regressions using just the observations for those individuals donating after 1999. Although apheresis is significantly less burdensome for the donor, some authors still consider bone marrow donation via aspiration preferable (Seitz et al., 2012.) Yet, because the financial and physical barriers to apheresis are lower than for aspiration, one might expect an increase in this type of donation, in particular from donors on the margin between donating and not donating. On the other hand, the introduction of leave and tax deductions for donation may allow donors to choose the more burdensome option of aspiration, which would not have been feasible without the leave laws and tax deductions to cover incidental expenses associated with donation. Only leave for private employees appears to have a marginally significant effect on the method of donation; it reduces donation by aspiration. This negative coefficient may be somewhat counterbalanced by the positive (but insignificant) coefficient for apheresis donations. It appears that although these laws have no effect on overall donations, they may have some effect on how individuals chose to donate. The other laws also yield opposite signed coefficients, although in favor of more “costly” aspiration. Again the estimates are not statistically significant.

²³ We performed similar analyses using year-to-year changes in donations, finding very similar results.

5.2.1 Bone marrow donations: Additional analyses

Balanced Panel. As with organs, we also consider the possibility that the main effect of these laws will occur shortly after their passage. Again, we take observations from five years before and five years after the passage of a law, omitting the year of passage, to determine if a more immediate, and perhaps less long-term, effect exists.²⁴ Again, we find no effect from these types of legislation on the number of bone marrow donations.

State employees as a share of the labor force. We also re-run our analysis controlling for the number of state employees, both total and full time, normalized by the state labor force to parallel the way we constructed the left-hand side variable. The results are reported in Table 11. Unlike with organs, this analysis does indicate a positive and significant effect from leave for state employees on bone marrow donations. In fact, although the main effect of leave for state employees is negative and usually insignificant, we find that the interaction between the rate of employment by the state and the existence of leave for state employees is positive and significant. The coefficient estimates of about -1.5 on leave for state employees and of 37.2 on the interaction term imply that leave for state employees has a positive effect if state employees represent at least 4.1 percent of the labor force, which is true for almost 48 percent of state-year observations in the data. Using just full-time employees (which account for 72% of state employees) yields similar results: the effect of leave legislation on bone marrow donations is positive if full-time state employees are at least 1.8 percent of the state labor force, which holds for 98% of state-year observations in our sample.

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 used for transplant. 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).²⁵ Another possibility is that the laws are affecting living and deceased donations differently. Fernandez et al. (2012) 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

²⁴ These results are available upon request.

²⁵ 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.

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 since the organ rapidly deteriorates without a blood supply and because this ensures that the recipient and donor are in the best health possible at the time of transplantation rather than allowing the timing of the transplant to be 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.²⁶

We consider, as a measure of the quality of the organ transplanted, the total number of grafts functioning for at least six months (or for three years in some regressions) as a share of the total number of transplants. In all of our regressions, we include a range of match, donor, and recipient characteristics that could affect survival as specified in Table 12.²⁷ Because survival data on bone marrow transplants are not available, we must limit the following analysis to just organ donations. Re-running the main regressions for this time period does not change the null effect of these types of legislation on the donor supply. Table 13 shows descriptive statistics for the quality outcome variables. Obviously, longer time periods are associated with higher death rates. Also, it appears that survival for recipients of living donations is higher than for recipients of cadaveric donors.

The regression results (from a linear probability model) are shown in Tables 14A through 14D. Overall, we find no effect of these laws on the quality of the organs donated as measured by the six-month state-level survival rate. When we consider the three-year survival period, however, we find some marginally significant evidence of a positive effect from leave for state employees. Since the pattern of coefficients is similar for six-months and three-years, and because significant factors external to transplantation can affect longer term survival, we focus predominantly on the six-month survival rates as the more accurate measure of quality.

We do find statistically significant differences among some subpopulations, which may indicate a shift in the distribution of organs used, even if overall we find no quality impact. In Table 14B we look at survival rates of recipients of female and male organs separately, further distinguishing between live and cadaveric organs. Leave for private employees increases the survival rate for recipients of live male

²⁶ In 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).

²⁷ 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, and underlying diagnosis.

organs by 5.5 percentage points (for comparison, the average six-month survival rate is 86 percent), whereas tax deductions for individuals increases the live female donor survival rate by almost 7 percentage points (compared to an average of 92 percent). The latter effect seems to be offset by a negative, marginally significant effect on recipients of live male organs.

Finally, we look at kidneys (Table 14C) and livers (Table 14D) separately. We find little or no effects for kidneys or livers when analyzed separately for six-month survival. For three-year survival rates, we find some marginally significant positive effects from leave for state employees and individual tax deductions for liver transplant recipients, which parallel in sign the coefficients for six-month survival. Leave for state employees leads to a 3.1 percentage point increase, and tax deductions for individuals leads to a 7.3 percentage point increase in the three-year survival rate of liver transplant recipients. The average survival rate among this population is 56 percent.

Overall, there is some evidence of a positive effect of leave for state employees on three-year survival rates, although the estimates are only marginally significant. Slightly stronger evidence of some positive effects on quality of leave for private employees and individual tax deductions also exists. 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.

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 this and in other 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 a third option, 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 is a costly decision for the living donor, and one that may hinge on financial (and work-related) considerations. Because of these costs, the efficacy of these laws is certainly not guaranteed. Donating bone marrow is also not likely a decision that is made lightly, but it is less burdensome. On this basis, if incentives have a positive impact on donation, we anticipated that the incentives examined would have a stronger effect on bone marrow than on organs.

Our results are consistent with this interpretation; we documented no impact of the legislation on the number of organ donations, and a positive impact on bone marrow donations. We also found some marginally significant evidence of a positive effect of the legislation on organ quality. 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 could 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.²⁸ (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.²⁹) 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. Employer-specific paid leave programs could further be diminishing the effect of leave laws.³⁰ Third, a composition 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 [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).³¹ Untangling these explanations is of importance for policymakers interested in increasing and enhancing the supply of organs for transplantation.

The positive effect of the legislation on bone marrow donations leads 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, such that the incentives analyzed here tip their decision, 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 (2012) and Lacetera, Macis and Slonim (2011, 2012) of a positive effect of leave legislation and \$5-\$15 gift cards on an even less invasive procedure, blood donation, further corroborate our interpretation.

²⁸ http://www.unos.org/docs/Living_Donation.pdf

²⁹ http://marrow.org/Registry_Members/Donation/Now_that_you_are_a_match_%28PDF%29.aspx

³⁰ 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. In addition, the American Society of Transplantation publishes an incomplete list of the names of private companies, including large organizations such as major state universities (Iowa, Minnesota, Ohio, and Wisconsin) offering paid leave to donate to their employees. Such initiatives could be obscuring the effects of legislation mandating unpaid leave.

³¹ 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>

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.³²

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³² 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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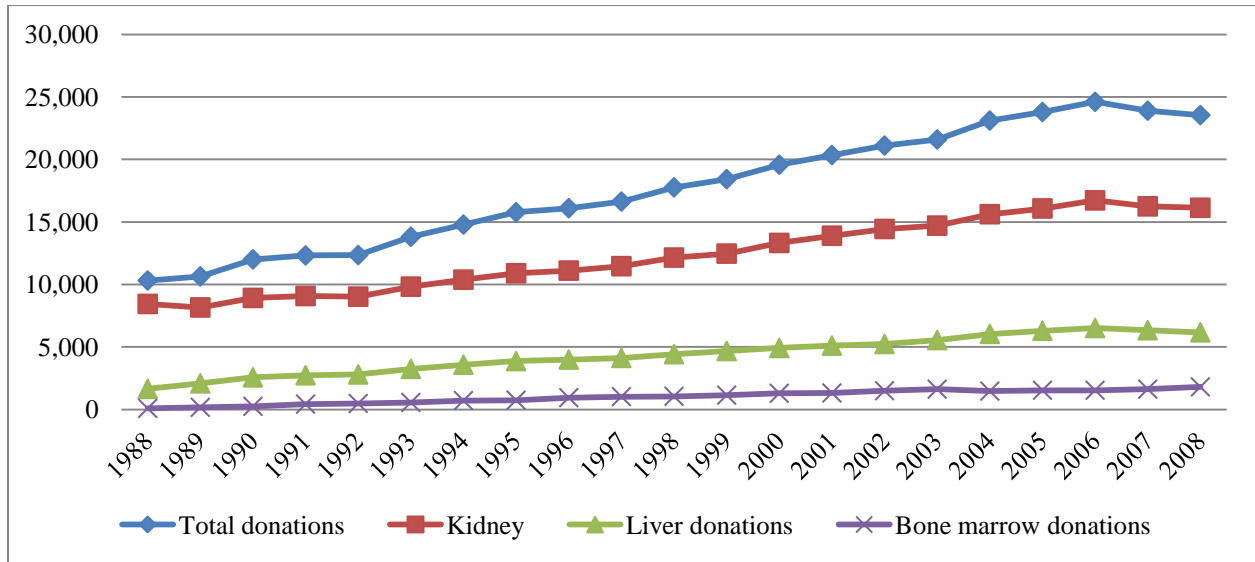
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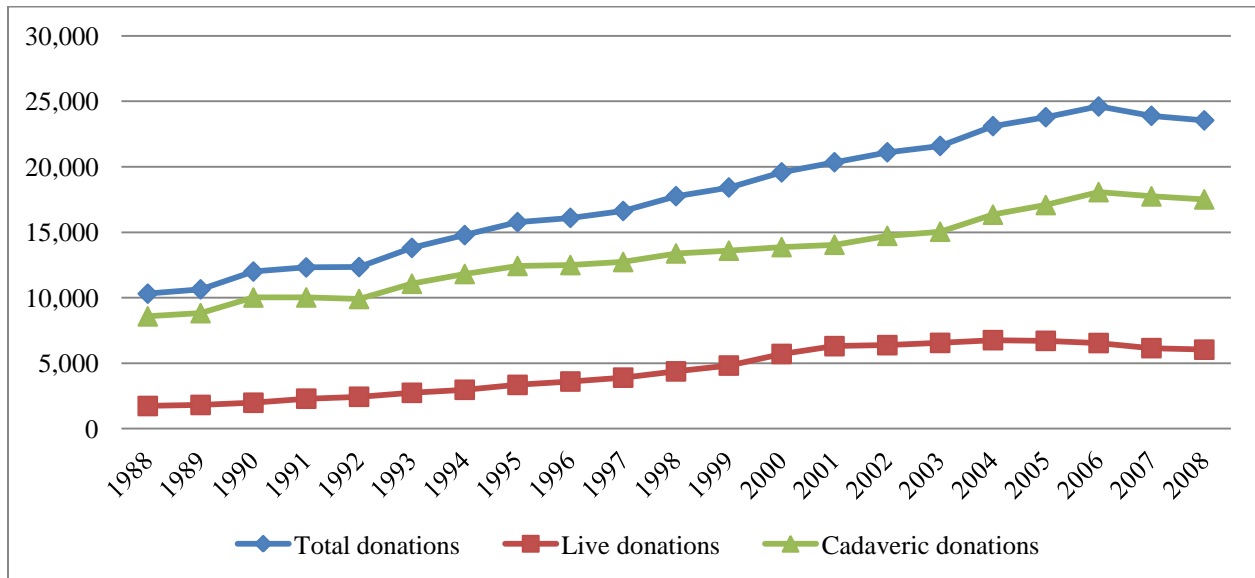
Figure 1: Donations by year

1A: Total donations by type of donation



Notes: OPTN data through 12/31/2008; NMDP data through 12/31/2008.

1B: Total donations by type of donor



Notes: OPTN data through 12/31/2008.

Table 1A: State laws for organ donors

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.

The following states have none of the above laws: AL, AZ, FL, KY, MI, MT, NE, NV, NH, NJ, SD, TN, VT, WY.

Table 1B: State laws for bone marrow donors

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	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	

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

The following states have none of these laws: AL, AZ, FL, KY, ME, MI, MT, NV, NH, NJ, NC, SD, TN, VT, WY.

Table 2: Descriptive statistics – Organ transplants per 1M population

Variable	State-year observations	Mean	Standard deviation	Minimum	Maximum
Total	1071	66.8	19.7	0.0	157.5
Live	1071	16.8	8.4	0.0	59.2
Cadaveric	1071	50.0	15.3	0.0	126.3
Male	1071	37.6	11.9	0.0	88.1
Female	1071	29.2	10.2	0.0	76.9
Livers	1069	16.1	6.2	0.9	48.5
Kidneys	1071	46.7	12.5	13.0	99.4
Live - male	1071	7.1	3.9	0.0	32.7
Dead - male	1071	30.5	10.4	0.0	78.1
Live - female	1071	9.7	5.1	0.0	36.1
Dead - female	1071	19.5	7.3	0.0	55.1
Live - Livers	1069	0.6	0.9	0.0	6.9
Dead - Livers	1069	15.5	6.0	0.9	46.7
Live - Kidneys	1071	16.2	8.0	0.0	59.2
Dead - Kidneys	1071	30.5	8.4	10.9	70.1

Notes: Data are from OPTN and cover the period from 1/1/1988 through 12/31/2008.

Table 3: Descriptive statistics – Live donor-recipient relationships

Variable	All	Kidneys	Livers
Total donations	77,760	74,363	3,397
Biological, blood-related parent	16%	15%	25%
Biological, blood-related child	17%	17%	25%
Biological, blood-related identical twin	0%	0%	0%
Biological, blood-related sibling	31%	32%	15%
Biological, blood-related half-sibling	1%	1%	1%
Biological, blood-related other relative	7%	7%	10%
Non-biological, spouse	10%	11%	6%
Non-biological, life partner	0%	0%	0%
Non-biological, unrelated: paired exchange	1%	1%	0%
Non-biological, unrelated: anonymous donation	1%	1%	1%
Non-biological, living/deceased donor exchange	0%	0%	0%
Non-biological, unrelated: domino	0%	0%	2%
Non-biological, other directed donation	15%	15%	16%

Notes: Data are from OPTN and cover the period from 1/1/1988 through 12/31/2008.

Table 4: Descriptive statistics – Bone marrow

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Bone marrow transplants per 1m population					
Total	1173	3.7	3.3	0.0	21.3
Female	1173	1.6	1.7	0.0	13.7
Male	1173	2.1	2.0	0.0	15.2
% of donation requests resulting in donation					
Total	1173	61%	27%	0%	100%
Female	1173	48%	32%	0%	100%
Male	1173	51%	31%	0%	100%
Apheresis versus aspiration per 1m population					
Apheresis	1049	2.4	3.4	0.0	22.7
Aspiration	1049	3.8	3.0	0.0	33.0
% of donations requests resulting in X type of donation					
Apheresis	1049	28%	32%	0%	100%
Aspiration	1049	72%	32%	0%	100%

Notes: The data for this table come from the NMDP and cover the period from 1/1/1987 through 12/31/2009.

Table 5: Descriptive statistics – Waitlist

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
Cumulative waitlist per 1m population	1020	480	352	4	1711
Cumulative waitlist per 1m population minus cumulative removals from waitlist per 1m population	1020	64	53	0	308
Cumulative candidates dying on waitlist or deteriorating until too sick for transplant per 1m population	1020	35	36	0	170
Yearly number of candidates dying on waitlist or deteriorating until too sick for transplant per 1m population	1016	5	4	0	21

Notes: Data are from OPTN and cover the period from 1/1/1988 through 12/31/2008.

Table 6: Probability of legislation passing
(Outcome = probability of law passing)

	(1)	(2)	(3)	(4)
	Leave for private employees	Leave for state employees	Tax deductions for individuals	Tax credits for employers
Cumulative waitlist per 1m population	-0.0149 (0.0242)	0.0106 (0.0102)	-0.00769 (0.0154)	-0.0113 (0.0109)
Observations	1,020	1,020	1,020	1,020
R-squared	0.120	0.125	0.147	0.149
Cumulative waitlist per 1m population minus cumulative removals from waitlist per 1m population since October 1987	0.0741 (0.0961)	-0.0518 (0.0396)	0.0882* (0.0525)	0.000502 (0.0329)
Observations	1,020	1,020	1,020	1,020
R-squared	0.120	0.125	0.148	0.148
Cumulative candidates dying on waitlist or deteriorating until too sick for transplant per 1m population	-0.170 (0.123)	0.0438* (0.0238)	-0.0311 (0.0724)	-0.0152 (0.0340)
Observations	1,020	1,020	1,020	1,020
R-squared	0.121	0.125	0.147	0.148
Yearly number of candidates dying on waitlist or deteriorating until too sick for transplant per 1m population	-0.226 (0.289)	0.0362 (0.131)	0.253 (0.161)	-0.0990 (0.0956)
Observations	1,016	1,016	1,016	1,016
R-squared	0.120	0.124	0.148	0.149

Note: 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.

*** $p < .01$, ** $p < .05$, * $p < .1$

Table 7A: Organs -- Main results
(Outcome = organ transplants per one million population)

Type of donations	(1) All	(2) All	(3) All	(4) All	(5) All	(6) Cadaveric	(7) Live
Leave for state employees	11.46*** (3.731)	-1.041 (2.848)	6.003*** (2.178)	-0.236 (1.762)	-1.204 (2.293)	-1.566 (2.061)	0.362 (1.008)
Leave for private employees	10.91* (5.782)	2.665 (5.610)	11.15* (5.702)	6.466 (4.608)	4.428 (6.333)	5.357 (6.327)	-0.927 (1.303)
Tax credits for employers	5.502 (4.861)	-3.641 (4.442)	-7.104 (6.848)	-4.188 (5.106)	-2.418 (6.823)	-1.655 (7.497)	-0.763 (1.172)
Tax deductions for individuals	8.139 (4.998)	1.153 (3.670)	-0.578 (4.006)	0.240 (2.419)	-1.419 (3.761)	-0.0303 (3.452)	-1.387 (1.292)
Year fixed effects		X		X	X	X	X
State fixed effects			X	X	X	X	X
State-year fixed effects					X	X	X
Observations	1,071	1,071	1,071	1,071	1,071	1,071	1,071
R-squared	0.160	0.458	0.562	0.693	0.734	0.624	0.830

Note: The data include the full unbalanced panel. State-level controls include unemployment rate and income per capita. State-level clustered standard errors in parentheses. *** $p < .01$, ** $p < .05$, * $p < .1$

Table 7B: Organs -- Results by gender
(Outcome = organ transplants per one million population)

Type of donation	(1) Male	(2) Cadaveric - Male	(3) Live - Male	(4) Female	(5) Cadaveric - Female	(6) Live - Female
Leave for state employees	-1.479 (1.425)	-1.874 (1.302)	0.395 (0.460)	0.275 (1.228)	0.308 (1.210)	-0.0331 (0.652)
Leave for private employees	4.260 (3.961)	5.214 (3.950)	-0.952 (0.839)	0.167 (3.322)	0.143 (3.161)	0.0252 (0.839)
Tax credits for employers	-1.666 (3.197)	-2.475 (3.886)	0.809 (1.166)	-0.752 (4.152)	0.820 (3.955)	-1.572 (1.068)
Tax deductions for individuals	-0.0578 (2.395)	0.244 (2.291)	-0.301 (0.663)	-1.361 (1.738)	-0.274 (1.615)	-1.086 (0.756)
Observations	1,071	1,071	1,071	1,071	1,071	1,071
R-squared	0.615	0.552	0.725	0.673	0.481	0.766

Note: 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. *** $p < .01$, ** $p < .05$, * $p < .1$

Table 7C: Organs -- Results for livers and kidneys separately
(Outcome = organ transplants per one million population)

	(1)	(2)	(3)	(4)	(5)	(6)
Type of donation	Liver	Live - liver	Cadaveric - liver	Kidney	Live - kidney	Cadaveric - kidney
Leave for state employees	-0.342 (0.730)	0.0362 (0.165)	-0.378 (0.736)	-0.979 (1.633)	0.295 (1.051)	-1.276 (1.280)
Leave for private employees	1.780 (2.530)	-0.479** (0.230)	2.259 (2.515)	2.124 (3.620)	-0.509 (1.319)	2.635 (3.538)
Tax credits for employers	-0.403 (3.035)	0.804 (0.545)	-1.207 (3.421)	-2.213 (3.487)	-1.527 (1.255)	-0.687 (4.049)
Tax deductions for individuals	-0.0744 (1.217)	0.315 (0.298)	-0.389 (1.184)	-0.494 (2.307)	-1.692 (1.370)	1.200 (1.956)
Observations	1,069	1,069	1,069	1,071	1,071	1,071
R-squared	0.735	0.575	0.722	0.704	0.814	0.523

Note: 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. *** $p < .01$, ** $p < .05$, * $p < .1$

Table 8: Organs -- Results by donor-recipient relationship
(Outcome = organ transplants per one million population)

	(1)	(2)	(3)
	Biologically related donors	Not biologically related donors (including spouses)	Not biologically related donors (excluding spouses)
Leave for state employees	0.000365 (0.0137)	0.00414 (0.0156)	0.0142 (0.0163)
Leave for private employees	0.0117 (0.0142)	-0.0281** (0.0106)	-0.0263* (0.0141)
Tax credits for employers	-0.0453** (0.0214)	0.0266* (0.0134)	0.0233 (0.0223)
Tax deductions for individuals	0.00499 (0.0147)	-0.0122 (0.0124)	-0.00161 (0.0111)
Observations	1,070	1,070	1,070
R-squared	0.978	0.621	0.468

Note: 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. *** $p < .01$, ** $p < .05$, * $p < .1$

Table 9: Organs – Results controlling for and interacting with state employment rate
(Outcome = organ transplants per one million population)

Type of donor	(1) All	(2) All	(3) Live	(4) Live	(5) Cadaveric	(6) Cadaveric
Leave for state employees	-6.211 (6.432)	-8.371 (6.309)	1.469 (3.328)	1.019 (2.909)	-7.682 (5.622)	-9.392 (5.825)
Leave for private employees	1.377 (8.737)	1.810 (8.840)	-0.686 (1.833)	-0.586 (1.869)	2.063 (8.018)	2.396 (8.132)
Tax credits for employers	2.444 (14.05)	2.011 (13.87)	-0.341 (1.852)	-0.467 (1.876)	2.785 (13.91)	2.478 (13.73)
Tax deductions for individuals	-1.012 (4.103)	-0.982 (4.211)	-1.552 (1.435)	-1.581 (1.462)	0.540 (3.786)	0.599 (3.856)
State employees/labor force	-54.42 (241.6)		53.92 (125.2)		-108.3 (207.5)	
Leave for state employees* (state employees/labor force)	98.75 (174.2)		-19.28 (82.43)		118.1 (148.8)	
Full-time state employees/labor force		311.1 (327.4)		115.7 (182.6)		195.5 (360.5)
Leave for state employees * (full-time state employees/labor force)		205.1 (232.5)		-13.37 (97.99)		218.5 (210.4)
Observations	784	784	784	784	784	784
R-squared	0.716	0.717	0.812	0.812	0.654	0.655

Note: 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. *** $p < .01$, ** $p < .05$, * $p < .1$

Table 10A: Bone marrow – Main results (donations)
(Outcome = bone marrow donations per one million population)

	(1)	(2)	(3)	(4)	(5)
Leave for state employees	1.611*** (0.345)	-0.585 (0.626)	2.370*** (0.284)	-0.922* (0.470)	0.0788 (0.397)
Leave for private employees	-0.676* (0.392)	-1.252** (0.611)	0.321 (0.320)	-0.749 (0.509)	0.165 (0.523)
Tax credits for employers	-1.288 (0.800)	-0.538 (0.951)	0.0487 (0.884)	-0.115 (0.650)	0.869 (0.825)
Tax deductions for individuals	0.222 (0.377)	-1.233* (0.630)	0.166 (0.378)	-1.066** (0.431)	-0.313 (0.441)
Year fixed effects		X		X	X
State fixed effects			X	X	X
State-level time trends					X
Observations	1,173	1,173	1,173	1,173	1,173
R-squared	0.038	0.380	0.356	0.650	0.780

Note: The data include the full unbalanced panel. State-level controls include unemployment rate and income per capita. State-level clustered standard errors in parentheses *** $p < .01$, ** $p < .05$, * $p < .1$

Table 10B: Bone Marrow -- Donations by gender
(Outcome = bone marrow donations per one million population)

Type of outcome	(1) Donations - female	(2) Donations - male
Leave for state employees	0.126 (0.248)	-0.0474 (0.193)
Leave for private employees	0.201 (0.268)	-0.0358 (0.302)
Tax credits for employers	-0.210 (0.277)	-0.103 (0.247)
Tax deductions for individuals	0.116 (0.390)	0.752 (0.460)
Observations	1,173	1,173
R-squared	0.615	0.715

Note: The data include the full unbalanced panel. All regressions include state and year fixed effects and state-level time trends. State-level clustered standard errors in parentheses. *** $p < .01$, ** $p < .05$, * $p < .1$

Table 10C: Bone marrow -- Donations by method
 (Outcome = bone marrow donations per one million population)

	(1)	(2)
	Apheresis donations	Aspiration donations
Leave for state employees	-0.202 (0.471)	0.253 (0.363)
Leave for private employees	0.634 (0.403)	-0.651* (0.379)
Tax credits for employers	-0.652 (0.830)	0.562 (0.648)
Tax deductions for individuals	0.879 (0.659)	0.387 (0.568)
Observations	507	507
R-squared	0.844	0.788

Note: The data include the full unbalanced panel. All regressions include state and year fixed effects and state-level time trends. State-level clustered standard errors in parentheses. *** $p < .01$, ** $p < .05$, * $p < .1$

Table 11: Bone marrow – Results controlling for and interacting with state employment rate

(Outcome = bone marrow donations per one million population)

Type of donor	(1) All	(2) All	(3) Female	(4) Female	(5) Male	(6) Male
Leave for state employees	-1.521* (0.813)	-1.382* (0.749)	-0.929 (0.709)	-0.855 (0.637)	-0.592 (0.374)	-0.527 (0.358)
Leave for private employees	0.120 (0.512)	0.0329 (0.501)	0.130 (0.269)	0.0741 (0.271)	-0.00958 (0.300)	-0.0412 (0.299)
Tax credits for employers	0.866 (0.840)	0.898 (0.808)	0.129 (0.413)	0.148 (0.393)	0.737 (0.454)	0.750* (0.443)
Tax deductions for individuals	-0.235 (0.413)	-0.197 (0.399)	-0.224 (0.263)	-0.197 (0.250)	-0.0118 (0.233)	-0.000537 (0.231)
State employees/labor force	-32.27 (33.52)		-16.34 (22.77)		-15.93 (39.20)	
Leave for state employees* (state employees/labor force)	37.16** (17.66)		23.99 (17.12)		13.17* (6.772)	
Full-time state employees/labor force		-77.54* (39.96)		-45.52 (38.55)		-32.01 (45.19)
Leave for state employees * (full-time state employees/labor force)		47.37** (22.47)		31.04 (21.53)		16.32* (9.331)
Observations	1,122	1,122	1,122	1,122	1,122	1,122
R-squared	0.789	0.789	0.626	0.626	0.727	0.727

Note: Includes the full unbalanced panel. State-level controls include unemployment rate and income per capita. All regressions include state and year fixed effects and state-level time trends. State-level clustered standard errors in parentheses. *** $p < .01$, ** $p < .05$, * $p < .1$

Table 12: Descriptive statistics – donor, match, and patient characteristics

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
% incompatible recipient-donor blood types	1071	14%	12%	0%	68%
% pediatric patients (<18 years)	1071	8%	3%	0%	30%
% multi-organ recipients	1071	2%	2%	0%	15%
% with diabetes diagnosis	1071	16%	5%	0%	38%
% with non-cholestatic liver disease	1067	55%	12%	0%	100%
Cold ischemia time	1071	13	3	6	26
Recipient age	1071	44	4	32	55
Days on waitlist	1071	395	132	55	907

Note: These percentages and averages are calculated for the whole sample. Subsample rates are used in subsample analyses.

Table 13: Descriptive statistics – quality outcome variables

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
% survive six months - all donor types	1071	86%	7%	36%	100%
% survive three years - all donor types	1071	62%	24%	0%	100%
% survive six months - live donors	1068	93%	8%	0%	100%
% survive six months - cadaveric donors	1071	84%	7%	41%	100%
% survive six months - female donors	1071	86%	8%	33%	100%
% survive six months - male donors	1071	86%	8%	17%	100%
% survive six months - live female donors	1062	92%	9%	0%	100%
% survive six months - cadaveric female donors	1069	83%	11%	0%	100%
% survive six months - live male donors	1056	93%	10%	0%	100%
% survive six months - cadaveric male donors	1070	85%	8%	0%	100%
% survive six months - kidney donors	1071	89%	7%	40%	100%
% survive three years - kidney donors	1071	65%	25%	0%	100%
% survive six months - live kidney donors	1068	93%	8%	0%	100%
% survive six months - cadaveric kidney donors	1071	87%	7%	43%	100%
% survive six months - liver donors	1067	78%	12%	0%	100%
% survive three years - liver donors	1067	56%	24%	0%	100%
% survive six months - live liver donors	579	80%	30%	0%	100%
% survive six months - cadaveric liver donors	1067	78%	12%	0%	100%

Table 14: Tax and leave effects on quality**14A: All organs**

(Outcome = state-level survival rate)

	(1)	(2)	(3)	(4)
Survival time	Six months	Three years	Six months	Six months
Type of donor	All	All	Live	Cadaveric
Leave for state employees	0.198 (0.506)	1.509* (0.761)	0.444 (0.794)	-0.0627 (0.614)
Leave for private employees	-0.0366 (0.838)	-1.042 (1.187)	0.402 (1.387)	0.323 (1.474)
Tax credits for employers	0.220 (0.690)	2.182 (1.733)	1.127 (1.012)	0.262 (0.874)
Tax deductions for individuals	0.827 (0.953)	1.561 (1.025)	2.985 (2.536)	0.579 (1.395)
Observations	1,067	965	579	1,067
R-squared	0.723	0.887	0.556	0.676

Note: The data 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-level time trends. Case mix controls: recipient age, recipient gender, diagnosis = noncholestatic v. other (livers), diagnosis=diabetes v. other (kidneys), live donor, and pediatric recipient. State-level clustered standard errors in parentheses. *** $p < .01$, ** $p < .05$, * $p < .1$

14B: Organs by gender

(Outcome = state-level six-month survival rate)

	(1)	(2)	(3)	(4)	(5)	(6)
Type of donor	Female	Male	Live - female	Live - male	Cadaveric - female	Cadaveric - male
Leave for state employees	1.172* (0.599)	-0.629 (0.807)	-0.148 (1.411)	0.648 (0.843)	1.407 (0.973)	-1.031 (0.869)
Leave for private employees	-0.648 (1.138)	0.983 (1.220)	-1.106 (2.656)	5.516** (2.118)	-0.487 (1.863)	1.062 (1.862)
Tax credits for employers	0.649 (1.019)	0.0985 (0.802)	1.109 (2.030)	-0.136 (1.243)	1.012 (1.199)	-0.0194 (0.920)
Tax deductions for individuals	-1.067 (1.129)	1.495 (1.534)	6.924** (3.112)	-4.020* (2.154)	-1.847 (2.218)	2.045 (2.384)
Observations	1,055	1,064	449	442	1,055	1,064
R-squared	0.563	0.583	0.579	0.613	0.465	0.540

Note: The data 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-level time trends. Case mix controls: recipient age, recipient gender, diagnosis = noncholestatic vs. other (livers), diagnosis=diabetes v. other (kidneys), live donor, and pediatric recipient. State-level clustered standard errors in parentheses. *** $p < .01$, ** $p < .05$, * $p < .1$

14C: Quality - Kidneys
(Outcome = state-level survival rate)

	(1)	(2)	(3)	(4)
Survival time	Six months	Three years	Six months	Six months
Type of donor	All	All	Live	Cadaveric
Leave for state employees	-0.121 (0.478)	0.726 (0.786)	0.872 (0.955)	-0.516 (0.657)
Leave for private employees	-0.0557 (0.950)	-0.780 (1.647)	0.847 (1.214)	-0.590 (1.371)
Tax credits for employers	-0.417 (0.625)	2.247 (1.875)	-0.366 (1.006)	-0.615 (1.109)
Tax deductions for individuals	-0.429 (0.943)	-0.918 (1.543)	-0.140 (1.496)	-0.631 (1.073)
Observations	1,071	969	1,021	1,071
R-squared	0.663	0.855	0.356	0.592

Note: The data 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-level time trends. Case mix controls: recipient age, recipient gender, diagnosis = noncholestatic v. other (livers), diagnosis=diabetes v. other (kidneys), live donor, and pediatric recipient. State-level clustered standard errors in parentheses. *** $p < .01$, ** $p < .05$, * $p < .1$

14D: Quality - livers
(Outcome = state-level survival rate)

	(1)	(2)	(3)	(4)
Survival time	Six months	Three years	Six months	Six months
Type of donor	All	All	Live	Cadaveric
Leave for state employees	1.502 (1.266)	3.089* (1.689)	-1.339 (4.603)	1.382 (1.294)
Leave for private employees	0.895 (2.223)	-1.320 (3.928)	-8.292 (13.57)	1.758 (2.411)
Tax credits for employers	1.910 (1.426)	0.236 (3.106)	-4.518 (10.44)	2.005 (1.401)
Tax deductions for individuals	3.092 (3.556)	7.318* (3.981)	1.747 (21.92)	1.639 (3.992)
Observations	1,067	963	490	1,067
R-squared	0.534	0.652	0.428	0.527

Note: The data 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-level time trends. Case mix controls: recipient age, recipient gender, diagnosis = noncholestatic v. other (livers), diagnosis=diabetes v. other (kidneys), live donor, and pediatric recipient. State-level clustered standard errors in parentheses. *** $p < .01$, ** $p < .05$, * $p < .1$

Appendix Table 1: Legal references

State	References
Alaska	HB 252
Arkansas	A.C.A. § 11-3-205; HB 2779; A.C.A. §21-4-215; HB 1393
California	Cal Ed Code §89519.5; Cal Lab Code §1510
Colorado	CRS 24-50-104; HB 1250
Connecticut	SB 1447; Conn Gen Stat § 17b-288; SB 327
Delaware	14 Del. C § 1318B; 29 Del. C. § 5122;
Georgia	OCGA § 47-7-27; OCGA § 45-20-31
Hawaii	HRS §78-23.6
Idaho	Idaho Code §59-1608; Idaho Code §63-3029K; Idaho Code §67-5343
Illinois	HB0324
Indiana	2002 Ind. PL 94
Iowa	Iowa Code §422.7; Iowa Code §70A.39
Kansas	Exec Order No. 2001-02
Louisiana	La RS 47:297; La RS 47:287.758; 1992 HB 428
Maine	26 MRSA §843
Maryland	Md State Personnel and Pensions Code Ann §9-1106
Massachusetts	ALM GL ch 62, §3; 2005 Acts Chapter 99 §1.33E
Minnesota	Minn Stat §181.945; Minn Stat §181.9456; S.F. No. 2840
Mississippi	Miss. S.B. 2981; Miss Code Ann §27-7-18; Miss Code Ann §25-3-103
Missouri	HB 679 (2001)
Nebraska	RRS Neb §71-4820; 1992 Neb LB 1099
New Mexico	NM Stat Ann §24-28-3; NM Stat Ann §7-2-36
New York	NY CLS Labor §202-b; NY CLS Tax §612
North Dakota	SB 2298, Ch 476; ND Cent Code §57-38-30.3
Ohio	ORC Ann 5747.01; ORC 124.139
Oklahoma	68 Okl St §2358; 74 Okl St §840-2.20B
Oregon	ORS §659A.312; ORS §315.604
Pennsylvania	35 PS §6120.2; 35 PS §6120.3
Rhode Island	2009 RI SB 76
South Carolina	S.C. Code §8-11-65; S.C. R. 61; 2005 SC R 373; 1992 S.C. R. 642
Texas	Tex Govt Code §661.916
Utah	Utah Code Ann §59-10-1015; Utah Code Ann 1953 §67-19-14.5; 2002 Ut. SB 125
Virginia	Va Code Ann §2.2-2821.1; Va Code Ann §58.1-322
Washington	Exec Order 02-01
West Virginia	W.Va Code §29-6-28
Wisconsin	2003 AB 477; Wis Stat §71.05; Wis. Stat §230.35