Direct and Indirect Effects of Policies to Increase Kidney Donations

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Abstract

A kidney transplant is a life-saving treatment for end-stage renal disease. Transplantable kidneys can come from living or deceased donors, but neither source of supply is keeping up with the growing demand. This study focuses on a model state law drafted in 2006, which has been enacted in 46 states and the District of Columbia as the Revised Uniform Anatomical Gift Act. The Act includes several measures that could increase supply of deceased donor kidneys. I use an event study approach to estimate the full effect of the Act on the supply of kidneys for transplant. The estimate is identified by arguably exogenous differences in timing of enactment across states over a seven year period. I find that the number of deceased donors of kidneys increases by five to seven percent as a result of the Act. The main channel for this effect is organ recovery from registered donors where unavailability or conflict among surviving family members would have prevented organ recovery under prior law. I find suggestive evidence of a corresponding reduction in living donors of kidneys, an indirect consequence of this law governing deceased organ donations.

Keywords: organ donation and transplantation, state laws
JEL: I11 (Analysis of Health Care Markets), I18 (Government Policy / Regulation / Public Health), K32 (Environmental, Health, and Safety Law)

1. Introduction

A price ceiling will generally lead to a shortage, with goods being rationed by another means besides willingness to pay. A particularly extreme example of a price ceiling is the ban on payments for organs for transplant, and we observe a particularly extreme shortage of donors. Focusing on kidneys, which can come from living or deceased donors, each year from 2010 through 2012 about 30,000 patients with end-stage renal disease joined waiting lists for kidneys, and while 16,000 left with transplants, another 7,000 died or became too sick to receive a transplant (OPTN, 2013).

Supply-side policies to decrease the kidney shortage work on both the living donor and deceased donor fronts. Kessler & Roth (2014) review a variety of efforts.[1] Policies to increase the supply of deceased donor kidneys focus on increasing the rate of kidney recovery among qualifying deaths.[2] This study focuses on one such policy, a model state law drafted in 2006, which has been enacted in 46 states and the District of Columbia as the Revised Uniform Anatomical Gift Act (UAGA). Relative to prior law, UAGA makes several changes that could increase the supply of deceased donor kidneys, and possibly indirectly decrease the supply of living donor kidneys.

Most important, UAGA provides a clear, uniform standard that

[1] Some efforts are already in place and successful, notably the matching schemes to better allocate living donor kidneys, as first proposed by Roth et al. (2004) and recently evaluated by Teltser (2015). Others are in still in the proposal stage, including payments to donors as discussed in Becker & Elias (2007) or implementing opt-out donor registries as in some other countries (Abadie & Gay, 2006).

[2] Several studies find that public health policies such as motor vehicle safety laws indirectly impact the supply of deceased organ donations, through the channel of reducing qualifying deaths (Dickert-Conlin et al., 2011; Fernandez et al., 2012; Fernandez & Lang, 2014).

registered organ donations made during life need not be confirmed by the family of the deceased (NCCUSL, 2006; Kurtz et al., 2007). Deaths allowing for recovery of organs are often sudden. Most commonly severe head trauma, a brain aneurysm, or a stroke leads to brain death, leaving limited time to authorize organ procurement, then recover and transplant the organs (AOPO, 2015). The combination of tragedy and time pressure means families can be preoccupied and unable to confirm the donation.

Existing research is unclear on the incidence of family conflict and the effect of donor consent laws at overcoming this barrier to transplantation. Staler et al. (2014) find that family conflict preventing organ donation is rare in Minnesota, while Gift of Hope (2006) states that 19 percent of registered Illinoisans had their donation overturned by family. Illinois enacted its own law strengthening donor consent to address this problem, but later enacted UAGA. Levin (2014) finds a 10 to 15 percent increase in donors as a result of pre-UAGA measures strengthening donor consent. Chatterjee et al. (2015) use a different definition of donor consent laws, and combine these laws with early impacts of UAGA, to find essentially no positive impact on donors. However the effects of UAGA could take time to develop. In 2012 when just 10 percent of states had not yet enacted UAGA, fully 20 percent of Organ Procurement Organizations said they would not proceed with organ procurement from a registered organ donor unless they had the consent of the family (Chon et al., 2013).

My study is the first to estimate the causal impact of eliminating family conflict and of other incremental changes included in UAGA. In an event study framework using nationwide data from 1988 through 2014, I look for increases in deceased donors following the enactment of UAGA. The estimated impact is identified by small variations in timing of enactment across states over a seven year period, after controlling for state and year fixed effects. I allow that the policy may have a growing impact over time, through doctors and hospitals settling into the practice of communicating with families under the new law, as well the time needed to grow donor registries under the stronger protections of UAGA. I focus on kidney donors as an upper bound of possible impacts, since the rate of kidney donation among donors is as high as that of any other organ (SRTR, 2015).

I find that the number of deceased donors of kidneys increases by 5 to 7 percent in the period after enactment of UAGA, using a simple difference-in-difference comparison. In a flexible event study specification allowing for growing impacts by years since enactment, I find an immediate small increase in donors that continues to grow to more than a 20 percent increase.

Studying kidneys also allows for exploration of indirect effects on living donors. Living donor kidneys provide significantly better graft survival rates than deceased donor kidneys (OPTN, 2013). However, altruistic live donations are costly to the donor. This cost can be felt indirectly by the patient who must search for a donor, usually among family and friends. Therefore a better chance of receiving a deceased donor kidney could reduce the use of live donors. To the extent that UAGA lowers living donations, this represents keeping a kidney in a healthy living donor while still allocating a kidney to the patient.

Numerous studies measure the extent of crowd-out. Segev et al. (2007)

find that transplant centers with longer wait times to deceased donation tend to have higher rates of living donations. Howard (2010) addresses possible endogeneity in these geographic associations and estimates a reduction of 0.2 living donor kidneys for each additional deceased donor kidney that becomes available. Beard et al. (2012) use time-series variation and find a larger reduction of 0.7. Fernandez et al. (2012) use motor vehicle safety laws as an instrumental variable and find a range of reductions from 0.2 to 0.5.

I find suggestive evidence that living donation is reduced in response to UAGA. The reduced-form effect of UAGA is a 4 to 7 percent decrease in living donors, though these estimates are imprecise and 95-percent confidence intervals include no reduction. I use UAGA as an instrumental variable to estimate the impact of deceased donors on living donors. Measuring by transplant to compare to earlier work, I find a point estimate of 0.7 fewer living donor kidneys per additional deceased donor kidney, but again the estimate is not statistically significant.

The following sections provide details on the changes made by UAGA, present an empirical strategy for measuring their effects, introduce data to support that strategy, report the results, and conclude with a brief discussion of the importance of UAGA in light of these results.

2. Organ procurement and state laws

Shortly after the first successful heart transplant, the National Conference of Commissioners on Uniform State Laws (NCCUSL) drafted the Uniform Anatomical Gift Act of 1968 and encouraged state legislatures to enact the model law.[3] The 1968 Act established the right to give organs after death. As it has in many other domains, NCCUSL (now called the Uniform Law Commission) filled a need for a clear and consistent legal standard across states. The need was especially strong in a rapidly evolving medical field, with logistical challenges of handling human organs under time pressure, and involvement of tragic accidents and bereaved families. The preface to the 1968 Act emphasized encouraging people to make anatomical gifts whenever possible (NCCUSL, 1968).

Though the 1968 Act was enacted universally, by the 1980s the same types of problems prompted a revision to the Act (NCCUSL, 1987). New technologies were making organ transplants more feasible, for more organs. At the same time demand for organs was growing beyond supply, partially because the supply of deceased donor organs was hindered by logistical and legal barriers. The 1987 Act made several incremental changes designed to increase efficient recovery of organs from eligible deceased donors, for example requiring that hospital staff inquire about donation surrounding all qualifying deaths (NCCUSL, 1987).

The incremental changes to increase supply continued in the states through first-person consent legislation and donor registries. Still, by the 2000s the results of a comprehensive review of legislation by the Association of Organ Procurement Organizations (AOPO) called for a third uniform law

[3]UAGA addresses full body, tissue, and eye donations as well as organ donations. Federal laws address the allocation of donated organs. The National Organ Transplantation Act of 1984 referred the responsibility of allocation to a network of state Organ Procurement Organizations. The non-profit organization currently contracted to oversee the network is the United Network for Organ Sharing (UNOS). Both state and federal laws prohibit selling organs.

to be drafted, resulting in the 2006 UAGA. The AOPO stressed uniformity and clarity, to facilitate more organ recovery to combat the shortage of organs.

Relative to prior law, the 2006 UAGA makes several changes related to deceased organ donation. First and most importantly, it protects anatomical gifts made during life from being overturned or not confirmed after death.[4] The law does not make a distinction between gifts made before or after enactment, but explicitly strengthens the interpretation of existing gifts that are valid at the time and place they were made.[5] The protection of gifts from being overturned by family was already in place through the 1987 Act and in many state laws, but the UAGA was still seen as necessary to provide very clear and consistent language to families and medical professionals that families are not needed to affirm donations made by their deceased family members.

Second, UAGA expressly provides for making an anatomical gift on a registry, particularly an online registry. Third, for persons who die without registering as donors nor denying that they would be donors, it expands the list of related persons who can make an anatomical gift on their behalf, and allows a majority rule in the case of objections (for example among surviving adult children). Fourth, it sets a default that withdrawal of life support should not interfere with organ recovery.

UAGA is a therefore bundle of changes with several possibilities to

[4] See Section 8(a) of NCCUSL (2006).

[5] To my knowledge only Oregon passed an explicit statement that the new law does not apply to gifts made before its effective date.

increase the supply of deceased donor kidneys, either immediately or through a chain of events. UAGA could immediately impact donations by allowing for recovery of organs in cases where family conflict would prevent recovery under less clear laws. The law's explicit recognition of gifts made in registries could prompt a state to create an online registry, which gives hospitals better information about who is a donor, and the creation of the registry could prompt a public marketing campaign to encourage donation. This was the sequence of events in Wisconsin, where UAGA was effective on April 1, 2008, the state's first online registry was opened March 29, 2010, and the registry reached one million members by October 13, 2011 (UW Health, 2011). Increased protection of gifts, better tracking of gifts, and motivating more people to register to give organs all should increase supply over time.

The potential magnitude of UAGA's effect depends on the amount of eligible deaths that do not result in donation. HHS (2015) reports that 65 percent of eligible deaths were converted into organ recovery in 2006.[6] By 2014 the conversion rate had risen to 75 percent (HHS, 2015). From 2007 through 2014, the percent of recovered deceased donors that were registered donors rose from 19 percent to 46 percent. Both trends suggest a growing role of obtaining and honoring first-person consent for deceased donation (Donate Life America, 2015). The next section lays out a plan to measure UAGA's role in these national trends, using cross-state comparisons.

[6] Here eligible deaths are patients that are brain dead and 70 years or younger.

3. Empirical model

For each state s and year t, I estimate a simple difference-in-difference panel regression:

$$Donors_{st} = \rho UAGA_{st} + \mathbf{X_{st}}'\boldsymbol{\beta} + \gamma_s + \delta_t + \sigma_s t + \varepsilon_{st} \tag{1}$$

This specification estimates the impact ρ of UAGA, within state-year covariates $\mathbf{X_{st}}$, state fixed effects γ_s, year fixed effects δ_t, and (optionally) within state-specific linear time trends with slopes σ_s. ε_{st} is a mean-zero error term. $Donors_{st}$ is defined using deceased donors that led to kidney transplants, and later living donors instead. To normalize states of different sizes and look for percent changes in donors, I will either divide donors by state population in millions in that year, or take the natural log of the donor count. The only covariate I include is motor vehicle fatalities, also either divided by state population in millions or in natural logs.

I can allow for more flexibility in the UAGA effect by year after enactment, while also checking for placebo effects in years before enactment, in an event study regression of a similar form:

$$Donors_{st} = \sum_{k=\ldots,-2,-1,1,2,\ldots} \phi_k UAGA_{st+k} + \mathbf{X_{st}}'\boldsymbol{\lambda} + \eta_s + \nu_t + \zeta_s t + \epsilon_{st} \tag{2}$$

Now the effects ϕ_k represent the impact of the kth year in which UAGA has been in effect, relative to the year before enactment.

For these estimates to represent the causal impact of the policy, I assume parallel trends in donation would have existed across states, but for the enactment of UAGA (or assume parallel deviations from state trends, after controlling for covariates, when these are included). The main threat to this assumption is some other force acting to change donations that is timed across states and years in exactly the same way as enactment of UAGA, or in terms of equation (1) above, if ε_{st} is correlated with $UAGA_{st}$.

Factors that make up the residual ε_{st} are unobserved state- and year-specific events that affect the supply of donors, such as other policy changes. I do not know of any other relevant policy change that was timed coincidentally with UAGA. Variation in timing of enactment $UAGA_{st}$, which also determines variation in $UAGA_{st+k}$ in equation (2), could come from differences across states in advocacy for the law by the public, by medical organizations, or by legislators.

One way supply and advocacy could be correlated is that efforts to boost donation rates could include multiple fronts, such as advocating for enactment of UAGA and at the same time educating the public about donating for unregistered family members, and recruiting people to join existing donor lists. To the extent that this kind of effort happened at different times in different states, and was the main source of variation in timing of UAGA, my estimates would attribute the impact of all these efforts to the enactment of UAGA.

Efforts to boost donation through education and encouragement were probably ongoing in many states before, during, and after drafting of UAGA. Observing lead effects $\phi_{k<0}$ gives some indication whether there is a systematically timed effect, for example if the advocacy efforts tend to boost donation the year before the legislature can process UAGA, but efforts also lead to enactment.

It seems more likely that the relatively small differences in timing of enactment come exogenously from different states having varying unrelated legislative priorities that slowed enactment of UAGA. The Act was endorsed by numerous medical organizations, and nearly all states passed it in a short period of time, suggesting there is not much geographic difference in the desire to facilitate organ transplantation (ULC, 2015).

Even with a universal desire to facilitate organ donation, the particular changes that UAGA makes cannot operate until it is effective in a state, making room for a measured impact of the law.

4. Data

I downloaded public-use data from the Organ Procurement and Transplantation Network (OPTN) on living and deceased kidney donors at the state and year frequency. Every transplant that takes place in the United States is regulated and tracked by OPTN. I use all available full calendar years, from 1988 through 2014, and the panel is balanced. I match these data with state population estimates by year from the US Census Bureau and motor vehicle accident fatalities by state and year from the National Highway Traffic Safety Administration Fatality Analysis Reporting System (FARS). For the effective dates of UAGA I searched legislative records in all 50 states.

In operationalizing where and when UAGA is effective in these data, there are two sources of measurement error that will tend to attenuate my estimates: geographic and temporal.

Geographically, the law applies by state and the data do not exactly match up to state borders.[7] Donations are collected within Donation Service Areas (DSAs), shown in Figure 1, reproduced from OPTN (2013). Each of the 58 DSAs is associated with a principal state, but just 38 states and the District of Columbia appear in the OPTN data as principal states. Other states are completely covered by DSAs based in other states, while some principal states have multiple DSAs based in them. To the extent that a DSA stretches across state borders, some donors that reside in neighboring states other than the principal state will be included in the data associated with the principal state. Any mismatch in UAGA enactment between principal and neighboring states within a DSA will tend to attenuate the difference between pre- and post-enactment by mixing in different laws. For example, in the case that UAGA is effective in a neighboring state with parts inside the DSA, but is not effective in the principal state, I will err by counting increased donations in the neighboring state as pre-enactment. There is also some measurement error in using state population estimates when DSAs cross state borders.

Temporally, the first year UAGA is effective is usually not a full year of the policy, since effective dates are usually not January 1. Table 1 shows each state's effective date. The yearly frequency of the data will tend to attenuate positive impacts on donation measurable in the first year, by mixing in months before the law is in effect.

[7] The law applies where the donation is made, as long as the gift is valid where it was initially made (NCCUSL, 2006).

2006 was the final year before the first UAGA enactment. In 2006 the cross-state average kidney donors per million was 29.1, with an interquartile range of 19.6 to 27.0. Living kidney donors per million was more dispersed with a mean of 27.7 and an interquartile range of 11.9 to 30.3.

A key assumption for identification of the parameters of the models above is that states would have parallel trends in donors absent the enactment of UAGA. This can be examined directly in the years leading up to 2006. States can be grouped into cohorts by the year they enacted UAGA. Figure 2 shows trends in deceased donors per million population by cohort. The figure is simplified to include just three large cohort groupings in only the pre-period. Twelve states enacted UAGA first in 2007, twelve states plus the District of Columbia did so in 2008, and the fourteen states that enacted later or not at all are grouped together here. The cohorts look to be on similar paths in the years before the first enactment, suggesting they might have continued this way in the absence of UAGA.

5. Direct effects of UAGA on deceased donors

Overall I find a robust, statistically significant, and meaningful impact of UAGA on deceased donation rates. This section describes results using a simple difference-in-difference panel (equation 1) as well as a more flexible event study (equation 2), measuring the dependent variable as the natural log of deceased donors and as deceased donors per million state population.

Table 2 reports regression results for four different versions of equation (1), varying whether state-specific linear time trends are included. Standard errors in parentheses are clustered at the state level to allow for serial correlation of error terms within a state.

Without controlling for time trends, the log coefficient implies a 12 percent increase in deceased donations in the period after enactment of UAGA. Time trends shrink this estimate to 7 percent, which is still statistically significant at the five-percent level.

The corresponding estimates per million state population are an increase of 2.7 donors per million and 1.5 donors per million. The estimate of 1.5, with time trend controls, is statistically significant at the ten-percent level. Comparing 1.5 to the 2006 sample mean of 29.1 implies a 5 percent increase.

Event study coefficients for deceased donors are shown graphically in Figure 3 and Figure 5. These regressions include state-specific linear time trends, as these were shown to be important in the simple difference-in-difference specifications. These images allow for an assessment of the lead term coefficients, which I hypothesize should be near zero, and an assessment of the lag term coefficients, which can show growth in impacts over time. Each point compares donations in a particular year to the baseline of donations in the year before UAGA becomes effective in a state.

Log point estimates suggest that UAGA causes steady growth in deceased donors, starting with the first year of enactment. The estimated increase in donors rises from 6 percent in the first year to over 24 percent in the sixth year and beyond. However 95-percent confidence intervals for post-enactment years all include the simple difference-in-difference effect of seven percent. The lead term coefficients are generally near zero, with only two larger than 3.5 percent in absolute value. Their 95-percent confidence intervals all include zero, indicating the placebo effect was not significant.

Point estimates per million tell a similar story. The effect is statistically significant starting in the first year, and increases from 1.6 in that year to 6.3 in the sixth year and beyond. The largest absolute value for a lead term coefficient is 2.0, and none of the lead terms are statistically different from zero. The percent increase in donors per million closely tracks the percent increase implied by the log coefficient.

Motor vehicle accident fatalities generally do not change estimates very much when included (all results here include them). The coefficient estimates tend to suggest that motor vehicle fatalities are associated with increases in deceased donors, as expected. The magnitudes are sensitive to the inclusion of state time trends.

Finding more donors under UAGA means that prior law, in its various forms, was a binding constraint on organ donation. However these estimates could overstate the magnitude of increased supply if there is a corresponding decrease in living donors. I explore this possibility in the next section.

6. Indirect effects of UAGA on living donors

One way to assess the indirect effect on living donors is to estimate the reduced form impact by using living donors as the outcome in the specifications reported above. This specification is subject to the same assumption discussed above, that policy changes are not timed coincidentally with other forces acting to change the supply of living donors. Most living donors are found among family and friends, and therefore public advocacy at the state-year level is less likely to impact who donates (OPTN, 2013). Implementation of kidney exchanges among living donors does not depend on state laws, and has been implemented mostly at university hospitals based on idiosyncratic interest and capacity (Teltser, 2015).

The reduced form estimates are less robust and precise for living donors relative to deceased donors, but tend to be negative and similar in magnitude. Focusing on specifications with state-specific linear time trends, Table 2, Figure 4, and Figure 6 do not contain any statistically significant coefficients at the five-percent level.

Unlike in the other event study specifications, the lead terms in the event study specification for living donors per million state population are larger, positive, and show a distinct downward trend leading up to the enactment year. This suggests that the negative impacts after UAGA, at least by this measure, may just be a continuation of a pre-trend, though it is not clear what would cause such a trend in living donations relative to UAGA enactment and the estimates are noisy.

Another way to assess the indirect effect on living donor supply is to use UAGA as an instrumental variable to estimate the effect on kidney transplants from living donors of a unit change in transplants from deceased donors in the following equation:

$$Liv.transplants_{st} = \pi Dec.transplants_{st} + \mathbf{X_{st}}'\boldsymbol{\mu} + \xi_s + \tau_t + \theta_s t + \omega_{st} \quad (3)$$

Equation (3) represents the second stage. The first stage is the same specification as equation (1), but measuring the dependent variable in transplants. A π coefficient of negative one would suggest full crowd-out.

This analysis requires the exclusion restriction that UAGA only affects living donation through its effect on deceased donation, which is reasonable since nothing in the law deals with living donations.

Table 3 shows the first and second stage estimates, measuring transplants in logs and per million population. On average a deceased donor leads to 1.5 kidneys transplanted (HHS, 2015). The 95-percent confidence intervals for the first stage estimates here include 1.5 times the reduced-form estimates for deceased donors.

The second stage estimates are both roughly -0.7, suggesting 0.7 fewer living donations per additional deceased donor kidney. Both are imprecisely estimated but suggest a level of crowd-out within the range found in prior studies. The point estimates suggest that 7 out of 10 of the changes in kidney allocation caused by UAGA provided a deceased donor kidney to a patient instead of a living donor kidney, while the other 3 out of 10 provided a deceased donor kidney to a patient instead of no kidney at all.

7. Conclusion

UAGA removed multiple barriers to organ transplantation from deceased donors. I find that this removal leads to a significant increase in the supply of donors of kidneys, by 5 to 7 percent each year. For each additional kidney from a deceased donor, I estimate a corresponding decrease of 0.6 kidneys from a living donor, though these estimates are not statistically significant.

The 2012 aggregate flows in and out of the kidney donation waitlist, reported in OPTN (2013), give a sense for the size of the impact of UAGA on the waitlist. Since deceased donor transplants accounted for roughly

11,000 of the 26,000 removals from the waitlist, an increase of 5 to 7 percent in deceased donors would lead to a proportional increase in transplants and increase the amount of patients taken off the waitlist by 550 to 770. Meanwhile over 92,000 patients remained on the waitlist at year's end.

UAGA has moved recovery rates higher, but the deadly shortage simply cannot be covered by deceased donations.

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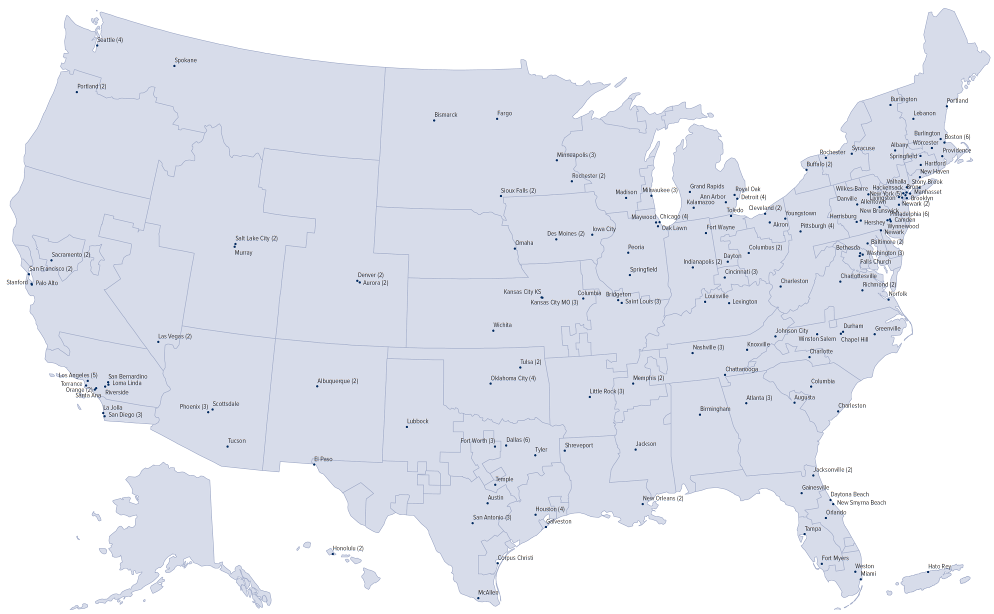
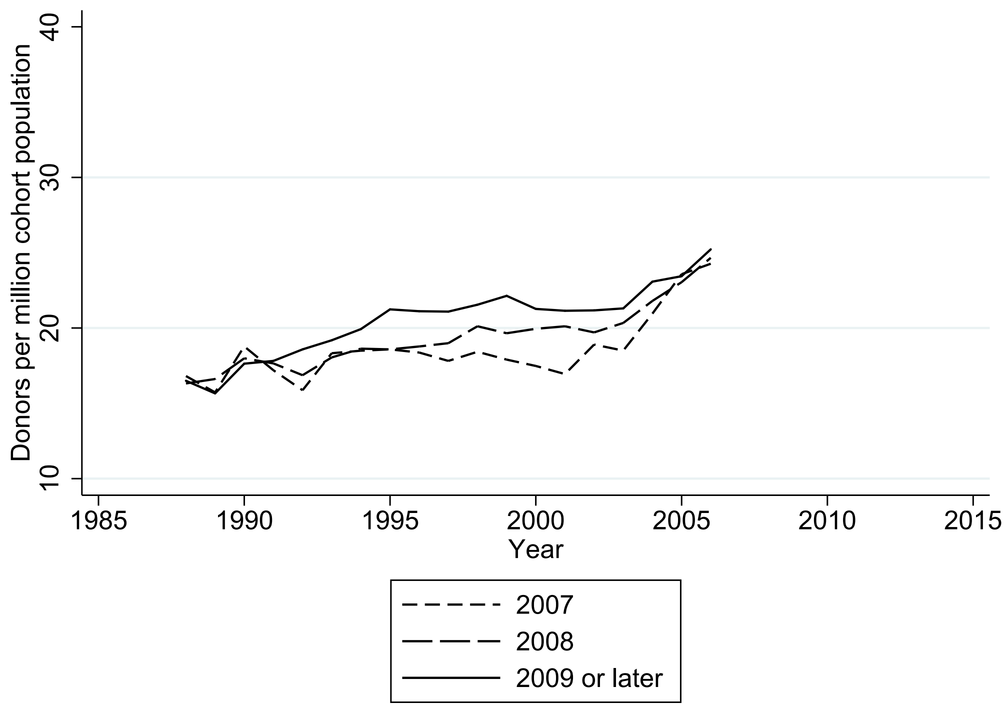
Figures and tables

Figure 1: Map of Donation Service Areas (DSAs), with transplant centers marked



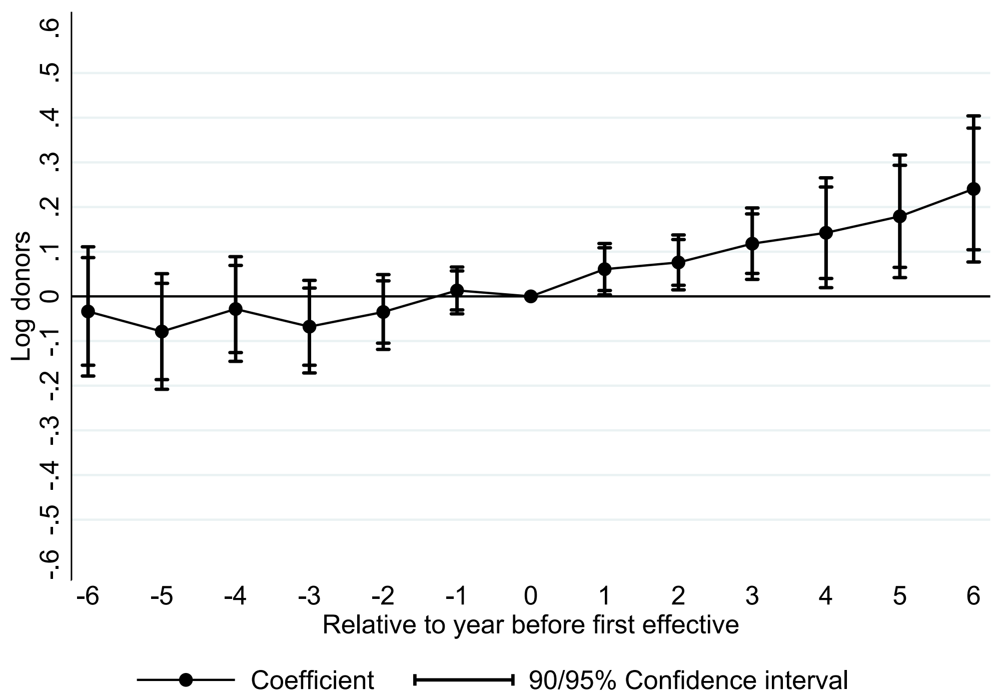
Source: OPTN (2013).

Figure 2: Pre-trends by enactment cohort groups: 2007, 2008, 2009 or later



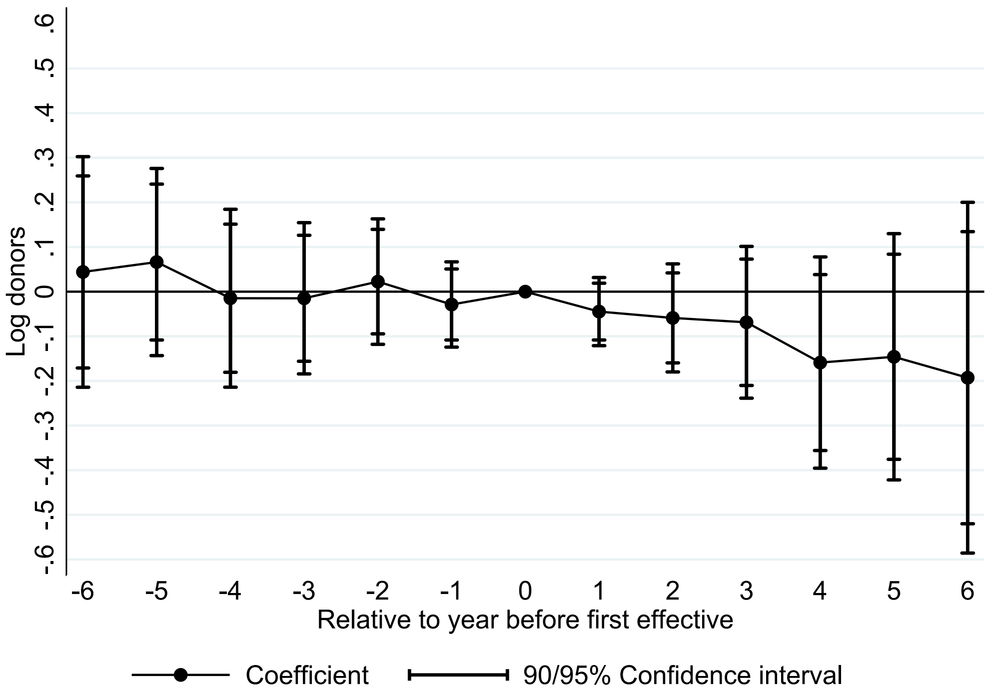
Sources: OPTN, US Census Bureau.

Figure 3: Event study results, log deceased donors



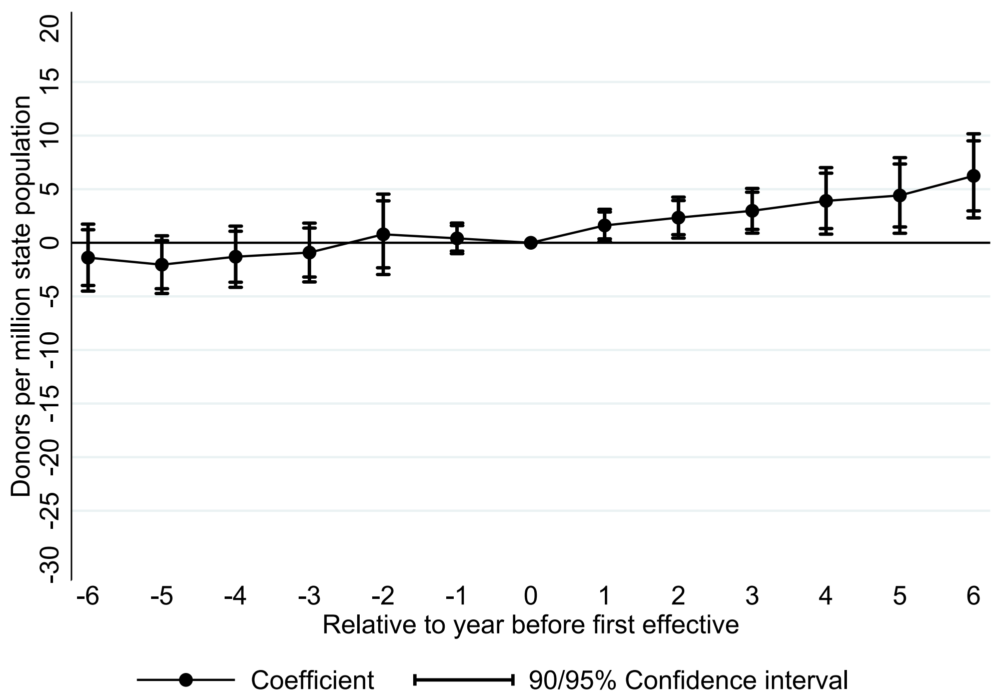
Sources: OPTN, FARS.
Specification includes state and year fixed effects, state-specific linear time trends, and motor vehicle fatalities (log). Standard errors are clustered by state.
Year 1 is the year UAGA is first effective for any part of the year. End values include 6 or more years before and after year 0.

Figure 4: Event study results, log living donors



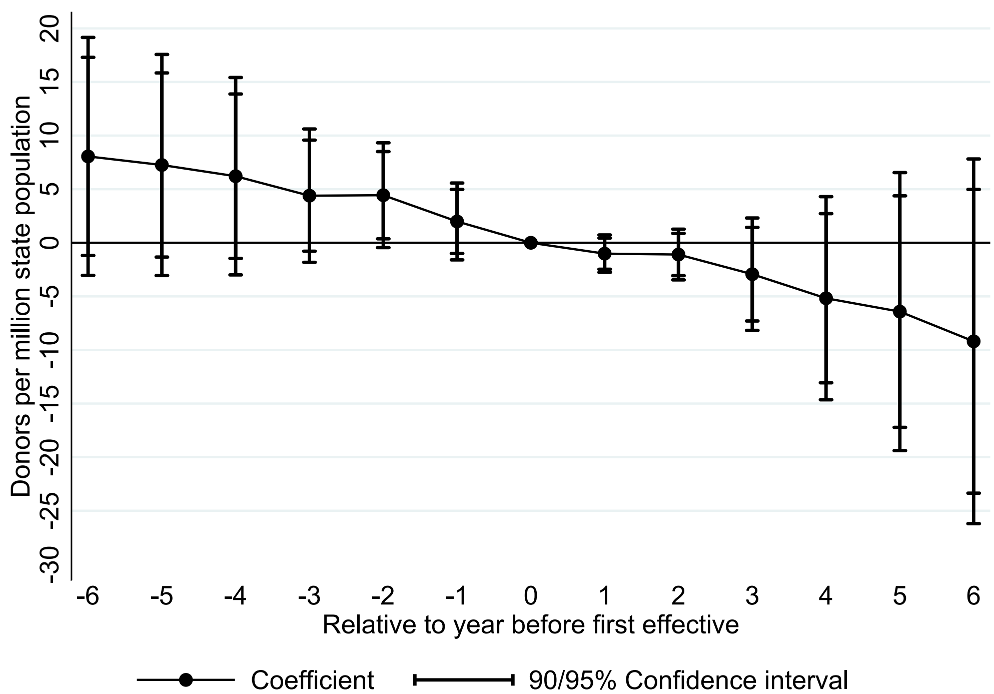
Sources: OPTN, FARS.
Specification includes state and year fixed effects, state-specific linear time trends, and motor vehicle fatalities (log). Standard errors are clustered by state.
Year 1 is the year UAGA is first effective for any part of the year. End values include 6 or more years before and after year 0.

Figure 5: Event study results, deceased donors per million population



Sources: OPTN, US Census Bureau, FARS.
Specification includes state and year fixed effects, state-specific linear time trends, and motor vehicle fatalities (per million). Standard errors are clustered by state.
Year 1 is the year UAGA is first effective for any part of the year. End values include 6 or more years before and after year 0.

Figure 6: Event study results, living donors per million population



Sources: OPTN, US Census Bureau, FARS.
Specification includes state and year fixed effects, state-specific linear time trends, and motor vehicle fatalities (per million). Standard errors are clustered by state.
Year 1 is the year UAGA is first effective for any part of the year. End values include 6 or more years before and after year 0.

Table 1: Effective dates of UAGA 2006, by state

State	Year	Month	Day	State	Year	Month	Day
Alabama	2008	November	1	Montana*	2007	October	1
Alaska*	2008	September	15	Nebraska	2010	July	14
Arizona	2007	September	19	Nevada	2007	October	1
Arkansas	2007	April	3	New Hampshire*	2010	July	31
California	2008	January	1	New Jersey	2008	July	22
Colorado	2007	July	1	New Mexico	2007	July	1
Connecticut	2010	October	1	New York	(not enacted)		
Delaware*	(not enacted)			North Carolina	2007	October	1
Florida	(not enacted)			North Dakota*	2007	August	1
Georgia	2008	July	1	Ohio	2009	April	7
Hawaii	2008	July	1	Oklahoma	2009	November	1
Idaho*	2007	July	1	Oregon	2008	January	1
Illinois	2014	January	1	Pennsylvania	(not enacted)		
Indiana	2007	July	1	Rhode Island*	2007	July	6
Iowa	2007	July	1	South Carolina	2009	May	6
Kansas	2007	July	1	South Dakota*	2007	July	1
Kentucky	2010	July	15	Tennessee	2007	July	1
Louisiana	2010	July	1	Texas	2009	September	1
Maine*	2008	January	1	Utah	2007	July	1
Maryland	2011	October	1	Vermont*	2010	July	1
Massachusetts	2012	February	13	Virginia	2007	July	1
Michigan	2008	March	18	Washington	2008	June	12
Minnesota	2008	April	1	West Virginia*	2008	June	4
Mississippi	2008	July	1	Wisconsin	2008	April	1
Missouri	2008	August	28	Wyoming*	2009	July	1
District of Columbia	2008	April	15				

* State not included in my regressions because it is subsumed by Donation Service Areas (DSAs) based in other states.
Source: State legislative records.

Table 2: Effects of UAGA on donors

	$\ln(Donors + 1)$			
	Deceased		Living	
UAGA	0.116***	0.071**	−0.129*	−0.036
	(0.039)	(0.032)	(0.075)	(0.055)
Motor vehicle accident fatalities (log)	0.339***	0.047	−0.357	−0.023
	(0.115)	(0.089)	(0.243)	(0.202)
State and year fixed effects	✓	✓	✓	✓
State-specific linear time trends		✓		✓
	Donors/million pop.			
	Deceased		Living	
UAGA	2.680	1.541*	−2.687**	−1.902
	(1.718)	(0.777)	(1.367)	(1.670)
Motor vehicle accident fatalities (pmp)	0.045**	0.004	0.035	0.006
	(0.019)	(0.016)	(0.048)	(0.056)
State and year fixed effects	✓	✓	✓	✓
State-specific linear time trends		✓		✓

* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

Sources: OPTN, US Census Bureau, FARS.

All regressions include 38 states and the District of Columbia observed in 1988–2014.

Standard errors (in parentheses) allow for correlation within a state.

Table 3: Instrumental variables effects of deceased transplants on living transplants

$\ln(\mathit{Transplants} + 1)$	
First stage: UAGA effect on deceased	0.053
	(0.039)
Second stage: deceased effect on living	−0.678
	(1.106)
Motor vehicle accident fatalities	✓
State and year fixed effects	✓
State-specific linear time trends	✓
Transplants/million pop.	
First stage: UAGA effect on deceased	2.681
	(1.911)
Second stage: deceased effect on living	−0.710
	(0.547)
Motor vehicle accident fatalities	✓
State and year fixed effects	✓
State-specific linear time trends	✓

* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$
Sources: OPTN, US Census Bureau, FARS.
All regressions include 38 states and the District of Columbia observed in 1988–2014.
Standard errors (in parentheses) allow for correlation within a state.