Can Increasing Access-to-Care Delay Accessing of Care?
Evidence from Kidney Transplantation

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ABSTRACT

Policies increasing healthcare availability might decrease the penalty of delaying accessing of care, leading to potential negative consequences if patients delay treatment. We analyze a policy designed to increase access to kidney transplantation through the use of time since dialysis inception to prioritize patients for transplant, which was piloted at 26 of the 271 kidney transplant centers in the United States in 2006 and 2007. We model the patient's optimization problem comparing the benefits and costs of early waitlisting and predict that the policy change will lead to delayed waitlisting. To empirically test this prediction, we use difference-in-differences fixed effects panel regression techniques to analyze data on patients who began dialysis between 1/1/2000 and 12/31/2009. The results support the model's prediction; patients on dialysis who waitlist for kidney transplantation increase pre-waitlist dialysis duration by 11.6 percent or approximately 76 days from a pre-policy mean of 652 days (SD=654). With regard to waitlist outcomes, the policy is associated with a 4.5 percentage point decrease in the probability of receiving a deceased donor transplant, somewhat offset by 3.0 percentage point increase in the probability of receiving a live donor transplant. On the extensive margin, patients on dialysis decrease their likelihood of ever waitlisting by 1.5 percentage points. We find an increase in pre-waitlist dialysis time and a decrease in the likelihood of waitlisting at all especially among populations likely to have experienced increased access to transplantation through the policy change: patients self-identifying as black or Hispanic rather than non-Hispanic white, and patients without private insurance. These results suggest that some individuals who face reduced access to healthcare may not benefit if their access to care increases, if the increase in access sufficiently decreases the penalty of delaying accessing of care.

Declarations of Interest: None

Keywords: Access-to-care; healthcare decision-making; kidney transplantation; dialysis; donor organ allocation

JEL: I12, I14, J18

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The authors thank Randall Sung, Alan Leichtman, Richard Hirth, Thomas Buchmueller, seminar participants at the University of Michigan, and audience members at the Southern Economic Association Annual Meeting and the American Society of Health Economics Biennial Conference for helpful comments and the University of New Mexico Robert Wood Johnson Foundation Center for Health Policy for funding support. Further, we acknowledge that "[t]his work is supported in part by Health Resources and Services Administration contract 234-2005-370011C. The content is the responsibility of the author alone and does not necessarily reflect the views or policies of the Department of Health and Human Services, nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. Government." http://optn.transplant.hrsa.gov/data/citing.asp

I. INTRODUCTION

A long literature in economics has studied how behavioral distortions can decrease expected policy benefits. Many healthcare-related policies, including the Affordable Care Act of 2010, seek to improve access to care, typically among the underserved. However, focusing primarily on whether or not the previously underserved were more likely to receive care may overstate the true value of the policy effect if the policy also causes behavioral distortions decreasing anticipated health benefits. In particular, improved access could delay accessing of healthcare if the increased availability of healthcare reduces the cost of delaying care or benefits of early accessing of care, and thus reduces the incentive for health investment at early stages of disease progression. If patients are then sicker at the time of care, this could lead to fewer treatment options being available and worse outcomes; in some cases, patients may never access care before becoming too sick to benefit from treatment or even succumbing to their disease altogether. As has been shown in other contexts in economics, the behavioral response diminishes the policy benefits and can lead to unintended costs (D. Dave & Kaestner, 2009; Klick & Stratmann, 2007; Peltzman, 1975; Stanciole, 2008). In this study, we examine this behavioral response in the context of kidney transplantation. We show that a policy diminishing the benefits of waitlisting for transplant as early as possible will cause patients to delay waitlisting. This behavioral change will entail unintended costs if patients have worse outcomes as a result. This prediction extends beyond end-stage renal disease to the many medical conditions that benefit from early diagnosis and treatment by appropriate specialists.

In this study, we examine a policy change designed to increase equity in access to transplantation by reducing the time from dialysis inception to waitlisting for transplant. Until April 10, 2014, the time spent on the waitlist was a primary determinant of priority for donor organs in the U.S. allocation algorithm for deceased donor and non-directed living donor kidneys, while time since dialysis initiation was not an included factor. In 2006 and 2007, 26 of 271 U.S. kidney transplant centers exchanged the time since waitlisting for the maximum of the time since waitlisting and the time since dialysis initiation in prioritizing waitlisted patients for kidney transplant. The inclusion of time since dialysis inception arose in part from increasing evidence that dialysis duration prior to transplant is a negative factor for post-transplant survival (e.g., Gill et al., 2005; Schold et al., 2010). Additional studies provided evidence that certain populations tend to have disproportionately long periods of dialysis pre-waitlisting. In particular, factors associated with being socioeconomically disadvantaged are correlated with longer periods of dialysis prior to waitlisting, including being a disadvantaged minority or having Medicare insurance (Danovitch, Cohen, & Smits, 2002; Keith, Ashby, Port, & Leichtman, 2008). With dialysis initiation much more closely tied to disease progression than the date of waitlisting, the policy was expected to improve access to transplantation, particularly for disadvantaged socioeconomic groups.

We use a simple theoretical framework to model the decision to waitlist in which tradeoffs between the benefits and costs of delaying waitlisting determine the timing of waitlisting. The policy change decreases the benefits of earlier waitlisting leading the model to predict increased delays in waitlisting. In order to test for delays in accessing care, we use data from the United Network for Organ Sharing in a difference-in-differences panel fixed effects regression framework. We analyze the effects of the policy change on whether and when patients choose to waitlist, and waitlist and transplant outcomes associated with these behavioral changes.

Our results show that, as predicted by our simple model, the average patient on dialysis delays waitlisting after the policy change, and on the extensive margin, decreases the probability of ever waitlisting. We furthermore show that these changes in waitlisting behavior were largest in the groups likely to have experienced the greatest increase in access to care. We find that patients also respond to mitigate the negative impact of these delays through the use of alternative treatment options, i.e., directed live donor transplants. To summarize, our results are consistent with an increase in the likelihood of being too sick to get a transplant but we find no changes in transplant outcomes among those who did get a transplant.

The results of this paper are relevant to the current U.S. national kidney allocation system, which, on April 10th, 2014, began including the time since the start of dialysis as an additional factor in prioritizing patients (along with wait time), and follows practices in Canada as well as other countries (The Canadian Council for Donation and Transplantation, 2006). To our knowledge, no studies have evaluated the effects of this policy change on pre-waitlist dialysis time.

A broader literature from economics supports our theoretical framework, going back to Peltzman (1975). Peltzman's canonical work showed that improved automobile safety standards led to a substantially smaller reduction in driving intensity than had been predicted because individuals re-optimized to a higher than predicted level of driving intensity thanks to the reduced cost of driving intensity created by the safety standards. Similar patterns were found in the health care context, where studies show that people reduce health investments when the consequences of bad health were covered by health insurance (Asfaw, 2019; D. Dave & Kaestner, 2009; Dave, Kaestner, & Wehby, 2019; Klick & Stratmann, 2007; Spenkuch, 2012; Stanciole, 2008). Stanciole (2008), Dave & Kaestner (2009), Spenkuch (2012), and Dave, Kaestner, & Wehby (2019) show that health insurance reduces preventive efforts (preventive care, exercise) and increases risky health behaviors (drinking, smoking). Asfaw (2019) shows that Medicare Part D led to decreased exercises and increased probablity of being overweight.

Klick and Stratmann (2007) shows that such behavioral adjustments could lead to worsened health outcomes. They find that diabetic patients gained weight after the enactment of state mandating private insurance to cover diabetes treatment, which may be particularly relevant to our results, given that diabetes is a frequent precursor to end-stage renal disease, the patient population we study.

This study also contributes to the literature in economics on transplantation, which has extensively studied factors affecting the flow of donor organs (e.g. Dickert-Conlin, Elder, & Teltser, 2019; Elías, Lacetera, & Macis, 2019; Fernandez, Howard, & Stohr Kroese, 2013; Hawley, Li, Schnier, & Turgeon, 2018; Howard, 2011; Lacetera, Macis, & Stith, 2014; D. Li, Hawley, & Schnier, 2013; Schnier, Merion, Turgeon, & Howard, 2018; Teltser, 2019). The economics of transplantation literature offers more limited guidance with respect to the recipient side of the transplant process, or more specifically, the transition from dialysis to transplantation and the market for transplant services more generally. What we do know is that patients and providers appear responsive to changes in regulatory requirements for quality reporting (Howard, 2011; Stith & Hirth, 2016), but selective referral with respect to volume and experience is not a major factor in where patients waitlist (Nicholas & Stith, 2019; Stith, 2018). These studies suggest patients and transplant centers are likely to be aware of significant policy changes, but that proximity still largely determines where patients waitlist. his study contributes to the literature by examining the timing of when patients transition from having their care directed by dialysis providers to preparing for transplantation. The delays in waitlisting documented herein have implications for dialysis care, donor organ allocation, and transplantation markets. In so far as they are generalizable beyond transplantation, our results may highlight an important dimension of policies that diminish the benefits of early accessing of care.

II. CONTEXT

In 2014, 30 million individuals in the U.S. had chronic kidney disease with nearly 500,000 receiving dialysis treatment. Spending on end-stage renal disease accounted for 7.2% of Medicare paid claims costs or $32.8 billion (United States Renal Data System, 2017). Dialysis typically begins either when monitoring through primary care indicates sufficiently advanced kidney disease or when a patient arrives at the emergency room with kidney failure. Relative to dialysis, kidney transplants provide a longer life expectancy and substantially higher quality of life for patients with end-stage renal disease and is cheaper also for payers than ongoing dialysis (Matas & Schnitzler, 2004), with the primary limitation on the number of transplants performed the supply of donor kidneys. Despite the promise of kidney exchanges (e.g., Roth, Sönmez, & Ünver, 2007; Roth, Sönmez, & Utku Ünver, 2005; Teltser, 2019), waitlists continue to vastly exceed transplants performed with 100,000 on the waitlist and only 19,849 kidney transplants performed in 2017.[1] Of the transplants in our sample, 0.96% involved paired kidney donation, although the rate had increased to 2.6% by the end of our sample period in 2013. The disparity between supply and demand means that almost a quarter of patients die on the waitlist or leave the waitlist too sick to receive a transplant.

Any patient needing a deceased donor organ must waitlist with a transplant center. The waitlist process begins when a patient is referred to a transplant center for evaluation. If they meet the medical, financial, and social criteria for waitlisting, the patient can choose to join the waitlist for deceased donor organs. Medically, the patient must be sufficiently healthy to survive the surgery and post-transplant immunosuppression and potential rejection episodes and have the cognitive capacity to care for their organ post-transplant (Cahn-Fuller & Parent, 2017),

[1] https://optn.transplant.hrsa.gov/data/view-data-reports/build-advanced/. Accessed 09/18/2018.

potentially leaving many patients not just ineligible for transplant, but ineligible even for waitlisting. Financially, the patient must be able to cover the expenses associated with surgery and immunosuppression, which are extensive, even with insurance coverage.[2] Socially, the patient must have a sufficient social support network to facilitate outpatient care pre- and post-transplant (Cahn-Fuller & Parent, 2017) . The duration of the approval process may be extensive, especially for patients with difficulties physically reaching transplant centers or those without ready insurance coverage for treatment. Patients can list at multiple transplant centers, but insurers typically do not cover multi-listing. Patients with live organ donors approved for donation can bypass the waitlist, but those waiting for a deceased donor kidney must go through the organ allocation system administered by the Organ Procurement and Transplantation Network (OPTN).[3] Deceased donor organs are almost never directed donations (designated for a specific individual) due to the issues with the timing of death, and non-directed live donor kidneys go through general allocation process. At waitlisting a patients' information is entered into an online system called UNet, as required beginning in 1999 just prior to the start of our sample period on 1/1/2000. When a donor organ becomes available, the donor's information is entered in DonorNet (introduced in 2003 with mandatory national use by 2007) and computer algorithms determine a ranked list of matched transplant candidates (Gerber, Arrington, Taranto, Baker, & Sung, 2010). In general, kidneys are matched on the basis of blood type, blood haplotype, age (children versus adults) and waitlist time.[4] Donated kidneys are first allocated locally within one of the 58 donation service areas in the US. Each of the donation service areas

[2] For example, under Medicare, coverage is not 100 percent with patients paying 20 percent of doctor's services under Part A as well as a deductible for Part B. Average kidney transplant surgery costs were around $260,000 in 2011 (Bentley & Hanson, 2011) with $2,500 per month in immunosuppression costs for the life of the transplant (Kasiske, Cohen, Lucey, & Neylan, 2000).

[3] OPTN was established by the National Organ Transplant Act in 1984 and has been administered by the United Network for Organ Sharing (UNOS) ever since.

[4] As of 4/10/2014, dialysis time is also included as a prioritization factor.

is managed by an Organ Procurement Organization, all of which are part of the OPTN. If a match is not found at the local level, then the organ is offered at the regional level within one of the eleven regions in the U.S. before being offered at the national level. Some patients never receive a match and are eventually delisted as too sick for transplant or die while still waitlisted.

In 2006 and 2007, three Organ Procurement Organizations piloted an alternative prioritization system which back-dated the wait time relevant for donor kidney prioritization to the start of dialysis rather than beginning wait time with when patient contacted the transplant hospital, underwent all required pre-waitlisting medical testing, and obtained medical and financial approval by the center to be placed on its waitlist. On 4/29/2006, the California OneLegacy (CAOP) and the Michigan Gift of Life (MIOP) implemented the "Committee Sponsored Alternative Kidney Allocation System," which gave patients credit for dialysis time in addition to any time on the waitlist. On 1/24/2007, the Iowa Donor Network (IAOP) also joined the initiative. More than seven years later in 2014, the national kidney allocation algorithm was revised to include both dialysis and wait-time in prioritizing patients, along with other substantial revisions to the prioritization and allocation process (OPTN Policies, Policy 8: Allocation of Kidneys, 4/10/2014.)

III. THEORETICAL FRAMEWORK

In this section, we establish a simple conceptual framework to illustrate that a patient's decision on the timing of waitlisting depends on the perceived health benefits and the costs of waitlisting. The benefits of early waitlisting are primarily through an increase in the probability of receiving a transplant. Under the original allocation algorithm, earlier waitlisting is associated with earlier transplantation and a higher probability of ever receiving a transplant. Patients who initiate the process early would receive transplant education early to help them take on early steps to manage their health in order to stay eligible for transplant. For example, exercise and nutritional changes and supplementation can slow lean mass reduction and other "frailty" characteristics induced by the progression of kidney disease.[5] Moreover, patients on the waitlist receive regular monitoring by a transplant center, which should be able to ensure better, more targeted care than other medical providers, although the extent of proactivity varies by transplant center. For example, Medstar Georgetown Transplant Institute describes a patient-driven updating process while the University of Michigan Transplant Center describes a more interactive and center-driven process.[6] Overall, the benefits of waitlisting decrease over time as the disease progresses and expected transplantation probabilities decrease. Although shorter pre-waitlisting dialysis time leads to improved outcomes in our model and in practice (H. U. Meier-Kriesche et al., 2000), patients may choose to delay waitlisting if the costs of doing so are higher than the benefits. The costs of waitlisting include learning about the benefits of transplant and the waitlist process (Gordon, 2001; Salter et al., 2014), the costs associated with establishing a relationship with providers to obtain transplant information (Klassen, Hall, Saksvig, Curbow, & Klassen, 2002; Kucirka, Grams, Balhara, Jaar, & Segev, 2012), and the extensive testing associated with receiving the medical evaluation (Gordon, 2001). In order to be waitlisted, a patient also needs to demonstrate adequate insurance coverage or other sources of financial support (Dageforde, Box, Feurer, & Cavanaugh, 2015; Ganji et al., 2014). Because of Medicare coverage for specifically end-stage renal disease (apart from typical age and disability criteria), disparities may be less than in other areas of organ transplantation and healthcare provision.

[5] Frailty in kidney disease includes muscle wasting, weakness, low energy, slowness, lack of exercise endurance, and physical activity limitations (Musso, Jauregui, & Núñez, 2015).

[6] https://www.medstargeorgetown.org/our-services/medstar-georgetown-transplant-institute/general-information/becoming-a-patienttransplant-evaluation-information/#managing. https://www.uofmhealth.org/conditions-treatments/transplant/kidney-and-pancreas-transplant-process. Accessed 6/30/2020.

However, Medicare coverage for end-stage renal disease does not start until the fourth month after the inception of dialysis and includes a significant coinsurance rate.[7] Patients of lower socioeconomic status also may incur higher costs because they tend to have tighter liquidity constraints and generally less medical literacy with which to digest the potential benefits of transplant. Moreover, patients from some racial minority groups may face additional barriers to transplantation due to cultural beliefs (Hispanics and Native Americans in Sequist et al. (2004) and African Americans in Gordon (2001) and in Navaneethan & Singh (2006)), which could make delaying transplantation even more attractive than dictated by socioeconomic status alone. In most cases, the costs of waitlisting decrease over time, as the dialysis patient gradually obtains medical knowledge about the transplant process, completes the evaluation process for transplant, and accumulates the necessary financing for transplant.[8]

A patient will have the highest probability of transplantation if a patient waitlists earlier. However, waitlisting is costly, so patients may choose to delay waitlisting until the benefits outweigh the costs if costs exceeds benefits at the time of diagnosis. Figure 1 provides an example of how the relationship between costs and benefits can lead to delaying waitlisting. (See Appendix A. for alternative scenarios). At diagnosis (t=0), the costs of waitlisting are higher than the benefits. Therefore, the patient chooses not to waitlist at t=0. As time goes by, both costs (C(t)) and benefits (B(t)) decrease. The patient chooses to waitlist at time t*, when the costs equal the benefits. Notably, patients facing higher costs (those of lower socioeconomic status) are more likely to delay waitlisting and are expected to delay longer.

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[7] https://medicare.com/coverage/does-medicare-cover-a-kidney-transplant/ Accessed 09/26/2018.

[8] It is worth noting that patients who are "marginal" in their suitability for transplant may have an upward sloping cost curve as their conditions worsen over time. While we assume a downward slopping cost curve in the theoretical model, alternative scenarios including the case of upward sloping cost curve are discussed in appendix.

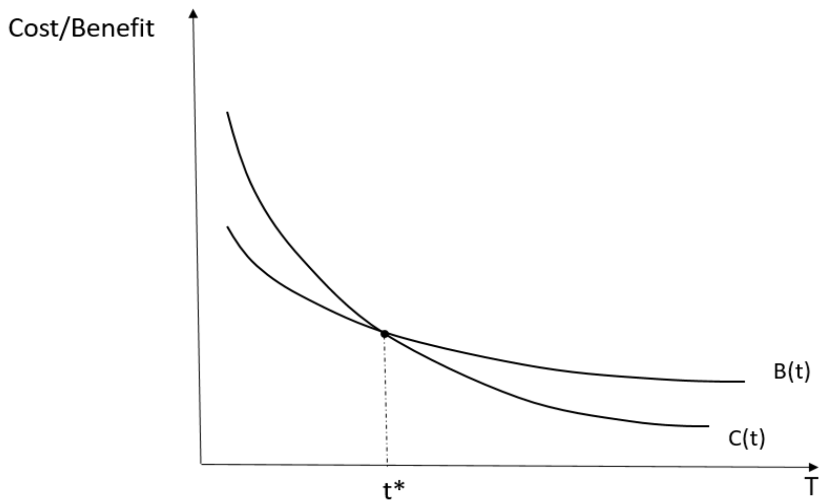

Figure 1. Costs and Benefits of Waitlisting: Baseline

Notes: The costs and benefits of waitlisting at time t are designated C(t) and B(t), respectively.

The policy change alters the benefits of waitlisting among patients already on dialysis. In particular, once on dialysis, waitlisting timing is no longer the primary driving of transplant timing. As a result, among patients on dialysis, those who delay waitlisting no longer face a disadvantage in in the allocation process after waitlisting and thus the benefit of earlier waitlisting is significantly smaller. Graphically, this change results in the benefit of waitlisting at time t becoming flatter, as shown in Figure 2. The new optimal timing of waitlisting is t**, which is later than the original t*.

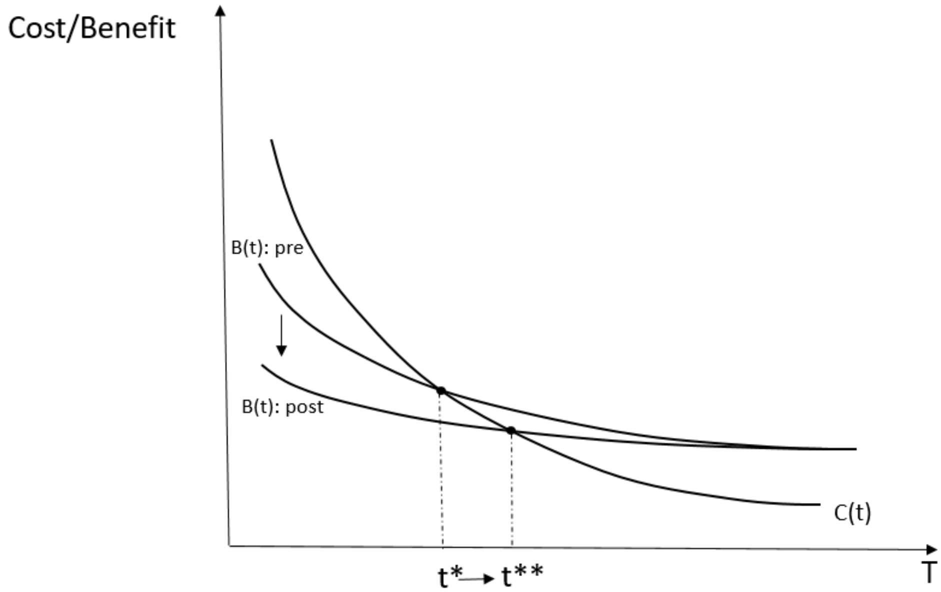

Figure 2. Costs and Benefits of Waitlisting: After Policy Change

Notes: The costs and benefits of waitlisting at time t are designated C(t) and B(t), respectively. “Pre” and “post” are relative to the policy change replacing wait time with the maximum of wait time and the time since dialysis inception.

Intuitively, the new algorithm changes the incentives faced by patients. Those who delay waitlisting beyond the inception of dialysis are no longer penalized in the form of delayed transplantation, and therefore, may further delay waitlisting.

IV. EMPIRICAL ANALYSIS

Data

The University of New Mexico Institutional Review Board deemed this study exempt from review due to the public accessibility of the data, widely available summary statistics, and de-identification of patients. From the United Network for Organ Sharing (UNOS), we obtained the data on all patients waitlisted for kidney transplantation between 9/30/1987 and 9/30/2013.[9] For our primary analysis, we restrict our sample to waitlisted patients who began dialysis between 1/1/2000 and 12/31/2009. We omit patients who began dialysis prior to 1/1/2000 to avoid contamination from prior policies. We omit patients beginning dialysis after 12/31/2009 in order to allow enough time for patients to decide when to waitlist, if ever. Dialysis began prior to waitlisting for 230,287 patients during our sample period. We further exclude 454 observations that lack information about disease category at waitlisting and payer type, leaving us with a final sample of 229,833 patients who began dialysis between 1/1/2000 and 12/31/2009 and were waitlisted prior to 12/31/2013, including 196,238 who were delisted, and 101,534 who were transplanted during our sample period. In addition, we conduct supplementary analysis on patients who waitlisted prior to beginning dialysis, i.e., patients who will be prioritized on the basis of wait-time rather than dialysis time as under the old policy. Focusing on this sample allows us to explore spillovers effects from the policy change. To do so, we used a sample of 17,947 patients who waitlisted prior to dialysis inception with waitlisting dates between 1/1/2000 and 12/31/2009.

Our data for analyzing the extensive margin of waitlisting, i.e., whether the policy induced some patients to delay so long that they were no longer eligible to waitlist, come from the United States Renal Disease System (USRDS) and include patients who began dialysis in the United States between 8/11/1965 and 10/19/2012. We restrict these data to patients who began dialysis between 1/1/2000 and 12/31/2009, as with our UNOS sample. Our initial USRDS sample includes 1,135,525 individuals along with 759,984 patients who waitlisted after 12/31/1999, but died prior to the end of our sample period. The effective sample for the

[9] We thank to the Robert Wood Johnson Foundation Center for Health Policy for funding the data purchase.

regression analysis is further reduced due to non-reporting of insurance type, leaving us with 558,748 individuals in our overall sample, and 310,822 patients who died during the sample period. Because of the significant non-reporting issue, we run robustness checks omitting insurance type as a control variable.

Treatment Measurement

Three Organ Procurement Organizations piloted the policy replacing wait-time with the maximum of wait-time and dialysis time in prioritizing patients on the waitlist for transplantation. CAOP and MIOP started the policy on 4/29/2006, and were joined by IAOP on 1/24/2007. Twenty-six out of a total of 271 kidney transplant centers were affected by the policies, i.e., are within the affected Donation Service Areas (DSAs). For our most conservative and precise measure of treatment, we include as treated only patients waitlisted at the affected centers who began dialysis after the policy change and before 12/31/2009. Our UNOS data coverage ends on 9/30/2013, which gives patients who began dialysis by 12/31/2009 about 3.75 years to show up as waitlisted in our data, and for our post-delisting outcomes, to complete the waitlist and transplant process. Of the 229,833 individuals who began dialysis between 1/1/2000 and 12/31/2009, 196,238 (85.4%) had been delisted by the end of our sample period on 9/30/2013. As shown in Table 1, among patients who received dialysis prior to waitlisting, the mean dialysis time prior to waitlisting was 1.8 years (median = 1.2 years), mean time from waitlisting to delisting was 2.0 years (median = 1.6 years), and mean dialysis time prior to transplant was 3.2 years (median = 2.8 years).[10] Because the policy may also change the incentive to waitlist for patients already on dialysis who had not waitlisted by the time of the

[10] The mean time between dialysis inception and being delisted for death or as too sick for transplant was 4.5 years (median = 3.8 years).

policy change, we conduct two robustness checks. One, we omit anyone beginning dialysis shortly before or after the policy change (between 1/1/2004 and 12/31/2007), and two, we redefine treatment status using wait-list start dates between 1/1/2000 and 12/31/2009 rather than dialysis start dates. During the period of analysis, these 26 centers treated 10,364 (10.2%) of the 101,661 patients who received a kidney transplant and waitlisted 24,936 (10.8%) patients out of the 229,833 patients waitlisted for a kidney transplant nationwide. Among these patients, 16,880 were waitlisted at the affected centers prior to the policy change and 8,056 were waitlisted after the policy change.

In order to evaluate spillovers to those who waitlist prior to beginning dialysis, who now presumably face the possibility of individuals jumping ahead in line without warning, we also analyze the effect of the policy change on the probability that an individual waitlists before beginning dialysis. We use the date of waitlist from the UNOS data to determine treatment, i.e., waitlisting at an affected center after the policy change.

In our extensive margin analysis using the USRDS data, treatment is measured at the state level (California, Michigan, and Iowa) because the three affected DSAs are the largest in their states and historic information on counties included in DSAs does not exist. Our sample includes 469,416 patients who live in states that were never treated, 19,150 who began dialysis after 1999 but prior to the policy change in treated states, and 70,182 who began dialysis after the policy change in a treated state. Based on a sample end date of 10/19/2012 in our USRDS data and including all patients who began dialysis between 01/01/2000 and 12/31/2009, this gives the last patients to enter our sample almost three years to waitlist.

Table 1: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
<u>Waitlist Process Outcomes</u>					

Pre-waitlist dialysis time (days)	229,833	652	654	1	4,939
Wait Time (days)	196,238	747	655	0	3,650
Pre-transplant dialysis time (days)	101,666	1177	804	0	5,005
Waitlist Outcomes					
Received transplant	196,238	0.54	0.50	0	1
Received deceased donor transplant	196,238	0.41	0.49	0	1
Received live donor transplant	196,238	0.13	0.34	0	1
Died on waitlist	196,238	0.17	0.38	0	1
Deemed too sick for transplant	196,238	0.07	0.25	0	1
Post-Transplant Outcomes					
Dialysis within the first week post-transplant	101,534	0.20	0.40	0	1
Died within 6 months	92,423	0.08	0.28	0	1
Died within 1 year	80,058	0.09	0.29	0	1
Decision to Waitlist					
Preemptively waitlisted	242,118	0.07	0.26	0	1
Waitlisted	558,748	0.25	0.43	0	1
Waitlisted Prior to Death	310,822	0.09	0.29	0	1
Socioeconomic Status Proxy Variables - UNOS					
White	229,833	0.44	0.50	0	1
Black	229,833	0.31	0.46	0	1
Hispanic	229,833	0.17	0.38	0	1
Asian	229,833	0.06	0.23	0	1
Other race	229,833	0.08	0.27	0	1
Private payer	229,833	0.38	0.48	0	1
Control Variables					
Male	229,833	0.61	0.49	0	1
Age at waitlisting	229,833	49.56	13.23	18	91
Diabetes	229,833	0.36	0.48	0	1
Glomerular Disease	229,833	0.21	0.41	0	1
Socioeconomic Status Proxy Variables - USRDS					
White	558,748	0.53	0.50	0	1
Black	558,748	0.29	0.45	0	1
Hispanic	558,748	0.13	0.34	0	1
Asian	558,748	0.04	0.21	0	1
Other race	558,748	0.01	0.11	0	1
Private payer	558,748	0.28	0.45	0	1
Control Variables					
Male	558,748	0.56	0.50	0	1
Age at waitlisting	558,748	61.11	16.24	18	91
Diabetes	558,748	0.43	0.50	0	1
Glomerular Disease	558,748	0.08	0.28	0	1

Notes: All variables are from the UNOS data except the decision to waitlist variables and are based on patients who started dialysis between 1/1/2000 and 12/31/2009. The preemptive listing variable comes from the UNOS data and includes all patients who waitlisted between 1/1/2000 and 12/31/2009. The decision to ever waitlist variables come from the USRDS data and are based on patients who started dialysis between 1/1/2000 and 12/31/2009. Observation counts vary because in some cases only subsamples are affected, e.g., days on dialysis prior to transplant only applies to patients who received transplants.

Study Outcomes

Our primary outcome of interest is the time between the inception of dialysis and waitlisting. In order to attempt to evaluate downstream effects from delaying, we study two additional waitlist “process” outcomes (length of time on the waitlist prior to delisting and total dialysis time prior to transplant), five waitlist delisting outcomes (transplant, deceased donor transplant, live donor transplant, died on waitlist, and too sick for transplant), and three post-transplant outcomes (dialysis within the first week post-transplant and the probabilities of surviving six months and one year post-transplant). However, we must caution that these additional outcomes will suffer from selection because of long wait-times prior to delisting. For example, patients with very long wait-times prior to transplant may not have been delisted before the end of our study. To avoid the influence of outliers, we take the natural log of our continuous outcome variables: pre-waitlist dialysis time, time on the waitlist, and pre-transplant dialysis time.

As shown in Table 1, among the 196,238 individuals meeting our UNOS sample selection criteria, 54% were delisted with a transplant (41% deceased and 13% live donor), 17% died on the waitlist, and 7% were deemed too sick for transplant. Among those delisted with a transplant, 20% received dialysis within the first week post-transplant, 8% died within six months post-transplant, and 9% died within one year post-transplant., We further evaluate effects of the policy change on the probability of preemptively waitlisting, measured as a dichotomous variable. Table 1 shows that among individuals waitlisting for transplant, 7% do so prior to beginning dialysis.

Lastly, using the USRDS data, we examine whether the policy change lead to changes in the probability of waitlisting. In particular, if some patients appear to be delaying so much that they become ineligible for transplant, we would anticipate a decrease in ever waitlisting. Of 558,748 patients registered by the USRDS with end-stage renal disease between 1/1/2000 and 12/31/2009, 25% waitlisted for transplant by 10/19/2012. Among patients who started dialysis after 1/1/2000, but died prior to 10/19/2012, only 9% had waitlisted for transplant.

Methods

In addition to simple means comparisons, we use difference-in-differences approaches to analyze the overall effect of the policy on our waitlist process outcomes using the following baseline panel fixed effects ordinary least squares model:

$$Outcome_{iht} = \alpha_0 + \alpha_1 Post_{ht} + \boldsymbol{X}_i' \boldsymbol{\alpha_x} + \boldsymbol{\alpha_h} + \boldsymbol{\alpha_t} + \varepsilon_{iht}$$

Outcomes are measured for patient *i* at time *t*, at center *h* in the UNOS data and in state *h* in the USRDS data. $Post_{ht}$ is our {0,1} treatment variable. $\boldsymbol{X_i}$ refers to a vector of control variables including race and ethnicity (coded from two separate questions about race and ethnicity, respectively, into white, black, Hispanic, Asian, other race[11]), private payer, age at waitlisting (at dialysis inception in the USRDS data), gender, and primary diagnosis (diabetes, glomular disease, and other).

[11] Ninety-four percent of the patients in our sample identify as "US Citizen," with the majority of the reminder identifying as "Resident Alien."

Descriptive statistics for the control variables from the UNOS and USRDS samples are shown in Table 1. As far as racial and ethnic groups, whites tend to be under-represented and blacks over-represented in our sample of waitlisted patients relative to the general U.S. population (Humes, Jones, & Ramirez, 2011), likely due to the greater prevalence of dialysis among blacks.[12] Thirty-eight and twenty-eight percent of the UNOS and USRDS samples, respectively, report a private insurer rather than public payers, donation, out-of-pocket, free care, or other. We include year and listing center fixed effects and cluster standard errors at the listing center level in all regressions.

We confirm that pre-trends are unlikely to be driving our effects by graphing the raw data and using an event study framework, replacing the dichotomous treatment variable in our main regression with a series of five annual treatment leads and three lags, using years relative to the day of the policy changes. Periods for untreated centers are relative to 4/29/2006. In order to ensure that our results do not underestimate the effect of the policy due to the inclusion of the treatment leads, we follow Borusyak & Jaravel (2017) and re-run the regressions using only a post-treatment series of treatment lags. We conduct event studies for our primary outcome, pre-waitlist dialysis time, as well as for our extensive margin effects.

After evaluating the effects of the policy change on the overall population, we further analyze whether the groups the policy change was intended to benefit did, indeed, benefit from the change by running our regressions separately by racial/ethnic group and for patients with private insurance coverage versus those with other types of payers or free care.

We conduct a variety of robustness checks on our main results, varying the sample inclusion criteria to isolate the treatment effect. Our main analysis using the dates of dialysis

[12] https://www.usrds.org/2012/view/v2_01.aspx. Accessed 12/30/2019.

inception omits from treatment individuals who were already on dialysis at the time of the policy. In order to evaluate the extent to which these individuals affected our results, we re-run our main analyses using the larger sample defined by the dates of waitlisting rather than the dates of dialysis inception. We also run regressions omitting the years 2004 through 2007 in order to clearly compare patients whose waitlisting decision was unlikely to be affected by the policy change with patients likely affected.

V. RESULTS

<u>Descriptive Analyses and Outcome Trends</u>

Table 2 shows sample averages for the outcome variables for untreated centers and for treated centers separating the treated sample into pre- and post-policy change. We present p-values from t-tests for continuous variables and chi-squared tests for dichotomous variables comparing treated centers pre- versus post-policy change.

Table 2: Descriptive Statistics and Simple Hypothesis Testing for Outcome Variables

	Untreated		Untreated Pre- v. Post-	Treated		Treated Pre- v. Post-
	Pre-04/29/2006	Post-04/29/2006	P-Value	Pre-Policy Change	Post-Policy Change	P-Value
<u>Waitlist Process Outcomes</u>						
Pre-waitlist dialysis time (days)	710	543	<0.001	681	546	<0.001
Ln(pre-waitlist dialysis time in days)	6.02	5.86	<0.001	6.07	6.00	<0.001
Days on waitlist prior to delisting	786	631	<0.001	922	699	<0.001
Ln(days on waitlist prior to delisting)	6.14	5.95	<0.001	6.29	6.01	<0.001
Days on dialysis prior to transplant	1239	966	<0.001	1460	970	<0.001
Ln(days on dialysis prior to transplant)	6.83	6.63	<0.001	6.95	6.53	<0.001
<u>Waitlist Outcomes</u>						
Received transplant	0.55	0.55	0.003	0.52	0.54	0.003
Received deceased donor transplant	0.43	0.40	<0.001	0.37	0.32	<0.001

Received live donor transplant	0.12	0.15	<0.001	0.14	0.21	<0.001
Died on waitlist	0.18	0.16	<0.001	0.16	0.13	<0.001
Deemed too sick for transplant	0.06	0.07	<0.001	0.07	0.09	<0.001
Post-Transplant Outcomes						
Dialysis within one week post-transplant	0.21	0.18	<0.001	0.23	0.19	<0.001
Died within 6 months	0.07	0.10	<0.001	0.09	0.11	0.001
Died within 1 year	0.1	0.07	<0.001	0.1	0.07	<0.001
Decision to Waitlist						
Preemptively waitlisted	0.07	0.08	<0.001	0.07	0.09	<0.001
Waitlisted	0.10	0.08	<0.001	0.31	0.28	<0.001
Waitlisted Prior to Death	0.25	0.24	<0.001	0.14	0.10	<0.001

Notes: The "Untreated" sample includes those patients waitlisted at transplant centers that did not change their waitlisting policies. The "Treated" sample includes those patients waitlisted at centers that switched from waitlisted time to dialysis time. All variables except for the waitlist process outcomes are dichotomous. P-values test for differences pre- and post-policy change within the treated centers and are based on chi-squared tests for all of the variables except waitlist process outcomes, for which the p-values are based on two-sided t-tests.

Comparing treated centers pre- versus post-policy change, we find that pre-waitlist dialysis time increases while the total days on the waitlist and the number of days on dialysis prior to transplant decrease, suggesting the change depicted in Figure 3.

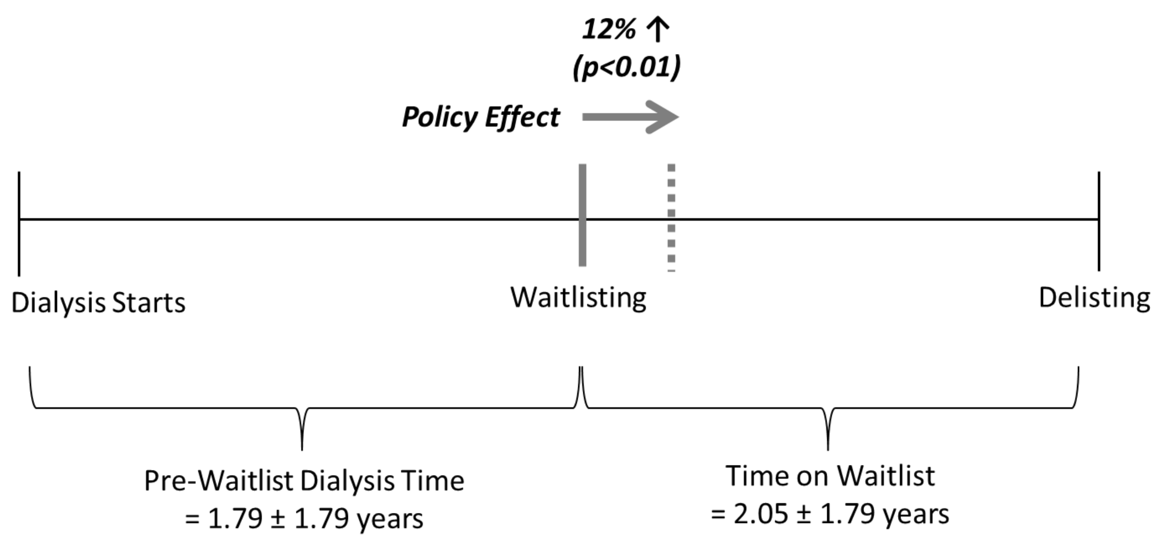

Figure 3. Study Timeline – Dialysis through Delisting

Notes: Pre-Waitlist Dialysis Time and Time on Waitlist are based on means and standard deviations from the raw data. The policy effect is based on the regression results.

In Figure 4, a Kaplan Meier graphical analysis of pre-waitlist dialysis time across the untreated, treated prior to treatment, and treated post-treatment is presented. The figure indicates that the treated centers tended to have shorter average pre-waitlist dialysis time than untreated centers prior to the policy change and but this relationship reversed with the policy change.

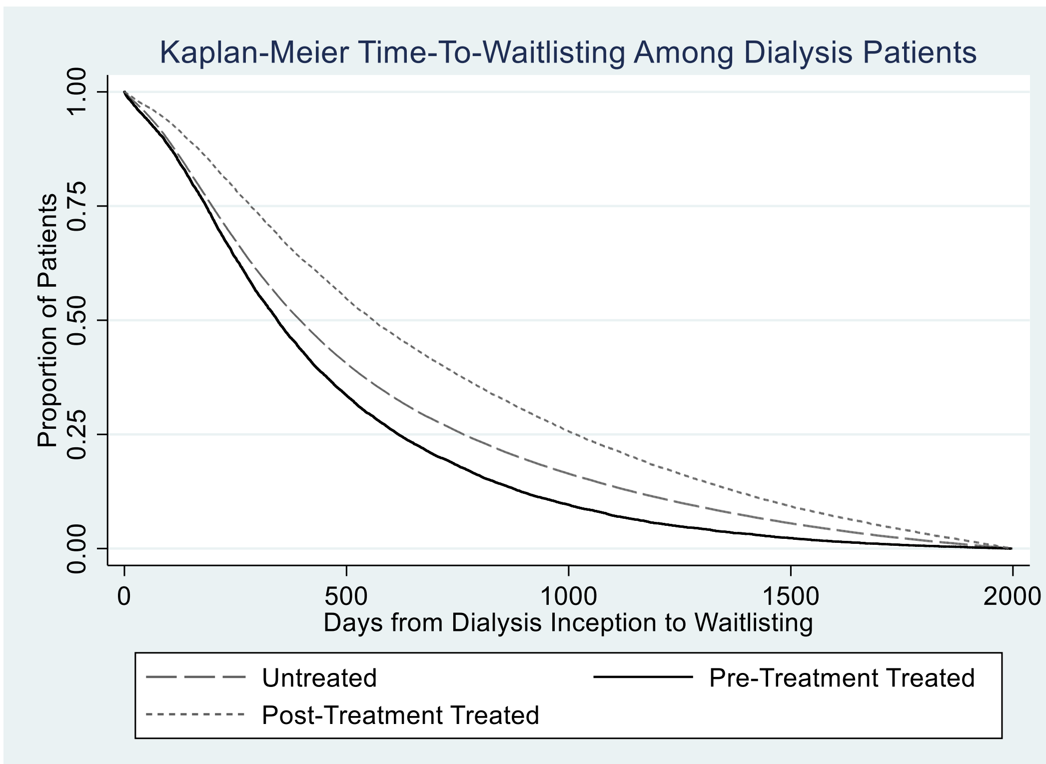

Figure 4. Kaplan-Meier Analysis

Notes: The above figure graphs the number of days from dialysis inception to waitlisting for the untreated centers using the whole sample period and differentiating between pre- and post-policy change for the treated centers. We include only patients with dialysis time of less than 2000 days, which removes major outliers but still covers more than 94% of the sample.

Means comparisons of untreated and treated centers pre-policy change is also informative, as shown in Table A1 of the Appendix. Our treated centers have worse outcomes prior to the policy change than untreated centers prior to 4/29/2006 except for the probability of dying within one year post-transplant, suggesting that center fixed effects will be important for our analysis. Appendix Table A2 shows differences across socioeconomic groups and control variables between untreated centers during the entire sample period and treated centers prior to the policy change and within treated centers pre- versus post-policy change. Systemic differences exist but they do not clearly indicate worse or better transplant outcomes. Untreated centers have higher proportions of patients self-identifying as black, who tend to have worse outcomes than average, but fewer patients with diabetes, another factor associated with worse outcomes. The descriptive statistics support the inclusion of center fixed effects and patient characteristics to control for differences in levels and patient populations across the two groups as well as potential endogeneity in levels associated with selection into the pilot policy.

Before implementing our regression strategy, we perform an initial assessment of pre-trends and post-trends across our treated and untreated centers, comparing differences in the raw data. Figure 5 shows little evidence of differences in a general downward trend in the natural log of pre-waitlist dialysis time prior to the policy change. For the untreated centers, no apparent break occurs at the time of treatment, but the treated centers experience a large and sustained increase in the natural log of pre-waitlist dialysis time relative to the untreated centers.

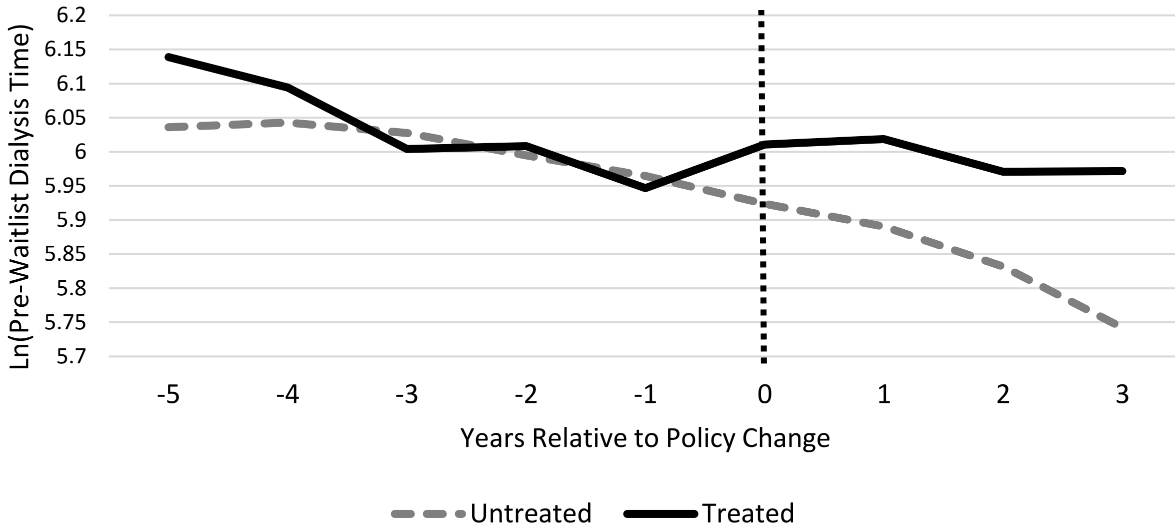

Figure 5. Trends in Ln(Pre-Waitlist Dialysis Time by Treatment Status

Notes: This graph compares the natural log of pre-waitlist dialysis time calculated from the raw data. For centers in the CAOP and MIOP donation service areas and the untreated group, the policy change occurs on 4/29/2006 (t=0). For patients receiving transplants at centers in the IAOP, treatment (t=0) occurs on 1/24/2007.

Main Analyses

Table 3 implements our regression strategy with the results following the changes depicted in Figures 3, 4, and 5. In other words, the timing of waitlisting is delayed leading to longer pre-waitlisting dialysis durations. We see an even greater decline in the number of overall days on the waitlist, suggesting better waitlist management, which is further supported by a decrease in pre-transplant dialysis time.

Table 3: Waitlisting Process - Regression Analysis

	(1)	(2)	(3)
Outcome:	Ln(Pre-Waitlist Dialysis Time)	Ln(Days on Waitlist)	Ln(Dialysis Time Pre-Transplant)
Dialyzed after Policy Change	0.110***	-0.158**	-0.143**
	(0.036)	(0.065)	(0.063)
Constant	5.431***	5.623***	6.343***
	(0.031)	(0.038)	(0.025)

Observations	229,833	195,472	101,657
R-squared	0.146	0.085	0.156

Notes: Each column represents a separate ordinary least squares regression with the outcomes listed in the column titles. The regression in the first column includes all waitlisted patients, the second includes only patients who were waitlisted and delisted, and the third column includes only patients who received transplants during our sample period. All regressions include age at waitlisting, gender, race/ethnicity, major disease category (diabetes, glomerular, and other), and year and center fixed effects. Standard errors are clustered at the center level. *** p<0.001, ** p<0.01, * p<0.05.

We further examine the change in pre-waitlist dialysis time using an event study framework, starting five years prior to the treatment date with the comparison group of centers anchored on 4/29/2006, the date when CAOP and MIOP implemented their pilot policies and following all centers through three years after the policy change. For IAOP, the x-axis measures years relative to 1/24/2007. The event study is based on regressions of the natural log of pre-waitlist dialysis time on five annual leads and three annual lags with the year of the policy change as the omitted category. The leads and lags are included independently and interacted with whether or not the patient was waitlisted at a treated center. The regressions otherwise follow the main regression specification. Figure 6 shows graphs of the coefficients on the interaction terms, which measure the differential effect of being in that period at a treated rather than untreated center. Because including a full set of leads and lags in the first panel of Figure 6 may underestimate the policy effect, we followed the recommendation of Borusyak & Jaravel (2017) and re-estimated our model including only the policy lags, with the results shown in the second panel. The graph including leads and lags indicates no obvious differential pattern pre-treatment, except for a slightly shorter average pre-waitlist dialysis time in the year just before and three years before the policy change. Following the policy change, pre-waitlist dialysis times appear to experience a sustained increase through the three years post-policy change. (The results underlying Figure 6 are reported in Appendix Table A3.)

We corroborate this outcome, using our broader sample and defining treatment based on the date of waitlist rather than the date of dialysis inception relative to the policy change. As shown in Figure 7, the results from such an event study are similar in that they also depict a sustained increase in pre-waitlist dialysis time. These graphs support both the predictions of our theoretical framework and the validity of our difference-in-differences regression design.

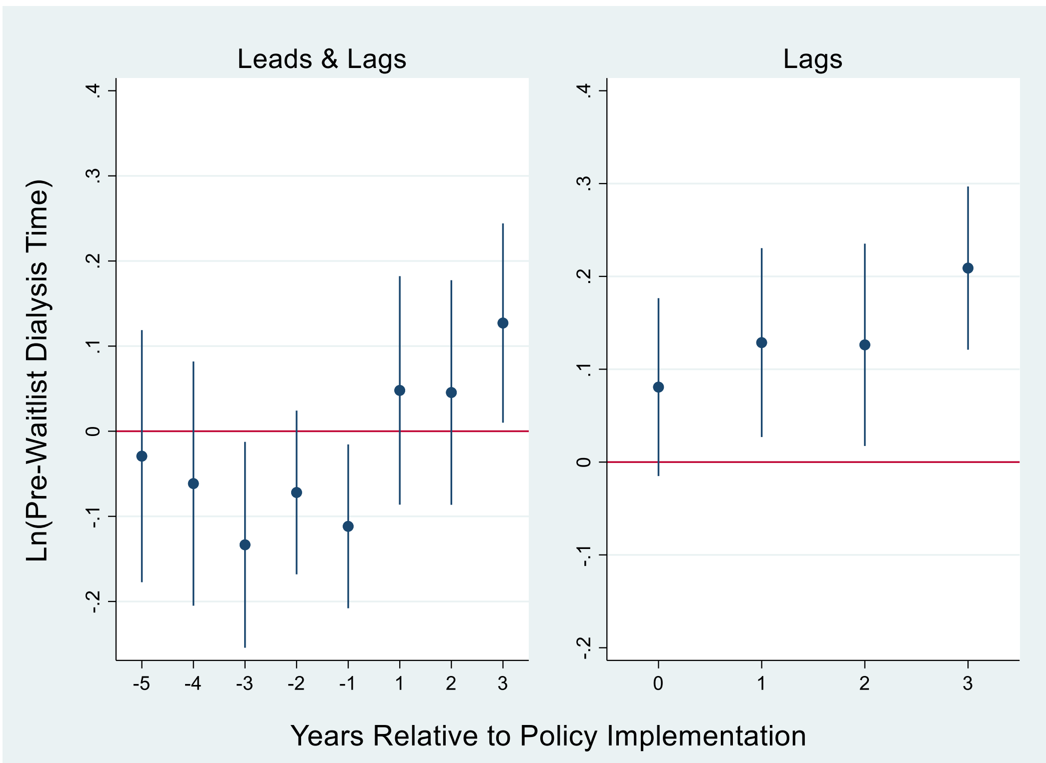

Figure 6. Effect of Pilot Policy on Ln(Pre-Waitlist Dialysis Time)

Notes: Graphs plot coefficients of interactions between policy leads and lags and treatment status with 95% confidence intervals. These coefficients were generated by regressions of ln(pre-waitlist dialysis time) on policy leads and lags, independently and interacted with treatment status, controlling for age, gender, race/ethnicity, major disease category (diabetes, glomerular, other) and center and year fixed effects. For centers in the CAOP and MIOP donation service areas and the untreated group, the policy change occurs on 4/29/2006 (t=0). For patients receiving transplants at centers in the IAOP, treatment (t=0) occurs on 1/24/2007. Confidence intervals are based on standard errors clustered at the center level.

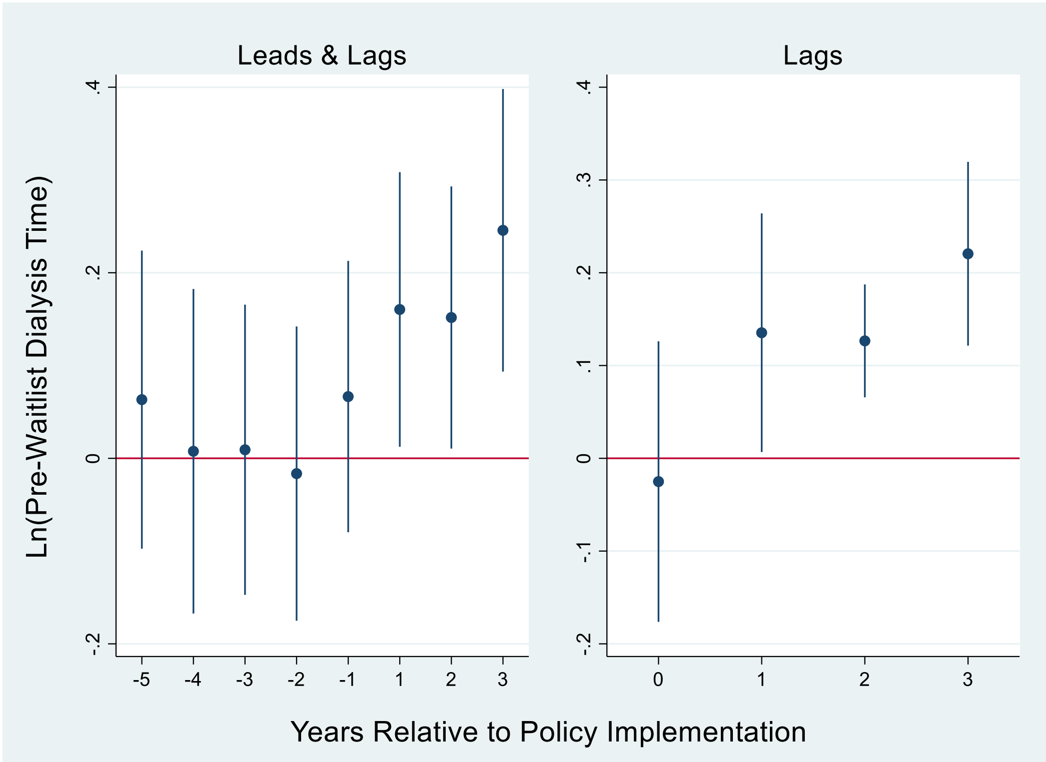

Figure 7: Effect of Pilot Policy on Ln(Pre-Waitlist Dialysis Time) Using Treatment Based on Date of Waitlisting

Notes: Graphs plot coefficients of interactions between policy leads and lags and treatment status with 95% confidence intervals. These coefficients were generated by regressions of ln(pre-waitlist dialysis time) on policy leads and lags, independently and interacted with treatment status, controlling for age, gender, race/ethnicity, major disease category (diabetes, glomerular, other) and center and year fixed effects. For centers in the CAOP and MIOP donation service areas and the untreated group, the policy change occurs on 4/29/2006 (t=0). For patients receiving transplants at centers in the IAOP, treatment (t=0) occurs on 1/24/2007. Confidence intervals are based on standard errors clustered at the center level.

In order to test whether the documented delays result in negative outcomes, we first examine how delisting reasons change with the policy change as shown in Table 4.

Table 4: Waitlist Outcomes – Regression Analysis

	(1)	(2)	(3)	(4)	(5)
Delisting Reason:	Transplant	Deceased Donor Transplant	Live Donor Transplant	Died on Waitlist	Too Sick for Transplant

Dialyzed after Policy Change	-0.015	-0.045***	0.030***	-0.010	0.011*
	(0.013)	(0.015)	(0.011)	(0.011)	(0.006)
Constant	0.732***	0.403***	0.329***	0.007	-0.069***
	(0.015)	(0.012)	(0.010)	(0.009)	(0.007)
Observations	196,238	196,238	196,238	196,238	196,238
R-squared	0.099	0.077	0.078	0.061	0.047

Notes: Each column represents a separate regression with the outcomes listed in the column titles. The regressions include all waitlisted patients on dialysis prior to waitlisting who left the waitlist during our sample period. All regressions include age, gender, major disease category (diabetes, glomular, other) and year and center fixed effects. Standard errors are clustered at the center level. *** p<0.001, ** p<0.01, * p<0.05.

The results in Table 4 suggest that the documented delay in waitlisting has negative downstream effects on waitlist outcomes. There is a decreased likelihood of receiving a deceased donor transplant, somewhat mitigated by an increase in live donor transplants. Although only marginally significant, the coefficient in column 5 suggests that the policy change may be increasing the likelihood of leaving the waitlist too sick for transplant.

We also test for negative impacts on post-transplant outcomes among those who receive transplants with the results shown in Table 5. Findings show no significant impact on post-transplant outcomes.

Table 5: Transplant Outcomes – Regression Analysis

	(1)	(2)	(3)
VARIABLES	Pr(Dialysis within 1st week post-transplant)	Pr(Died within 6 months)	Pr(Died within 1 year)
Dialyzed after Policy Change	-0.016	-0.005	0.005
	(0.017)	(0.011)	(0.020)
Constant	0.043***	0.007	0.139***
	(0.011)	(0.007)	(0.033)
Observations	101,534	80,058	60,707
R-squared	0.074	0.029	0.053

Notes: Each column represents a separate regression with the outcomes listed in the column titles. The regressions include only patients who received transplants. All regressions include age at waitlisting, gender, major disease category (diabetes, glomular, and other), and year and center fixed effects. Standard errors are clustered at the center level. *** p<0.001, ** p<0.01, * p<0.05.

Preemptive Waitlisting

We see clear effects on the likelihood of increased pre-waitlist dialysis time from the policy change, which could have spillover effects on the small portion of patients who waitlist preemptively before beginning dialysis. Although preemptively waitlisting prior to beginning dialysis still would unambiguously improve prioritization, the policy change decreases certainty with respect to total wait-time and the probability of surviving until an organ becomes available because patients not on the waitlist at the time of a given patient's waitlisting can later join and be prioritized ahead of that patient. Using the sample of individuals who waitlisted prior to beginning dialysis between 1/1/2000 and 12/31/2009, we test whether the policy change reduced the likelihood of preemptively waitlisting or affected waitlist outcomes among the population of patients who clearly did not delay waitlisting as a result of the policy change. Although we do not see an increase in preemptive waitlisting as shown in Table 6, we do see changes in how preemptively listed patients leave the waitlist using the date of waitlisting to determine treatment. As with the rest of the waitlist, preemptively waitlisted patients experience decreases in wait-time and pre-transplant dialysis time. In fact, the magnitudes are larger than in the waitlisted sample that received dialysis prior to waitlisting.

Table 6: Preemptive Waitlisting Process – Regression Analysis

Outcome:	(1) Pr(Preemptive Listing)	(2) Ln(Days on Waitlist)	(3) Ln(Dialysis Time Pre-Transplant)
Waitlisted after Policy Change	0.009	-0.264***	-0.263*
	(0.012)	(0.089)	(0.146)
Constant	0.087***	6.393***	5.630***
	(0.006)	(0.046)	(0.063)
Observations	342,688	20,502	18,735
R-squared	0.056	0.187	0.135

Notes: Each column represents a separate regression with the outcomes listed in the column titles. The omitted ethnic/race group is Non-Hispanic white. The regressions include all patients who waitlisted prior to beginning dialysis and left the waitlist during our sample period. All regressions include age, gender, major disease category (diabetes, glomular, other) and year and center fixed effects. Standard errors are clustered at the center level. *** p<0.001, ** p<0.01, * p<0.05.

Analyzing waitlist outcomes for the preemptively waitlisted provides further explanation, as shown in Table 7. The likelihood of receiving a live donor transplant increases, driving an increase in the probability of transplant and suggesting that because of the increase in uncertainty in the likely timing of transplant due to individuals with long dialysis times jumping ahead in line, many patients chose to find a live donor. This substitution pattern and flexibility in the size of the live donor supply was documented thoroughly in Fernandez et al. (2013). These results mirror a smaller effect found among those who began dialysis prior to waitlisting.

Table 7: Waitlist Outcomes Among Preemptively Listed

	(1)	(2)	(3)	(4)	(5)
Delisting Reason	Transplant	Deceased Donor Transplant	Live Donor Transplant	Died on Waitlist	Too Sick for Transplant
Waitlisted after Policy Change	0.068*	-0.006	0.074**	-0.012	-0.011
	(0.035)	(0.037)	(0.036)	(0.015)	(0.015)
Constant	0.907***	0.477***	0.430***	0.027***	-0.007
	(0.020)	(0.025)	(0.020)	(0.010)	(0.006)
Observations	20,628	20,628	20,628	20,628	20,628
R-squared	0.203	0.146	0.144	0.063	0.046

Notes: Each column represents a separate regression with the outcomes listed in the column titles. The omitted ethnic/race group is Non-Hispanic white. The regressions include all patients who waitlisted prior to beginning dialysis and left the waitlist during our sample period. All regressions include age, gender, major disease category (diabetes, glomular, other) and year and center fixed effects. Standard errors are clustered at the center level. *** p<0.001, ** p<0.01, * p<0.05.

Probability of Ever Waitlisting

In addition to predicting an increase in pre-waitlist dialysis time, our model predicts that some patients may delay so long that they are too sick to benefit from transplantation or succumb to their disease prior to waitlisting. We turn to the USRDS data set to analyze whether or not end-stage renal disease patients were more or less likely to waitlist at all following the policy change. Figure 8 shows an event study of the effect of the policy on the probability of waitlisting.

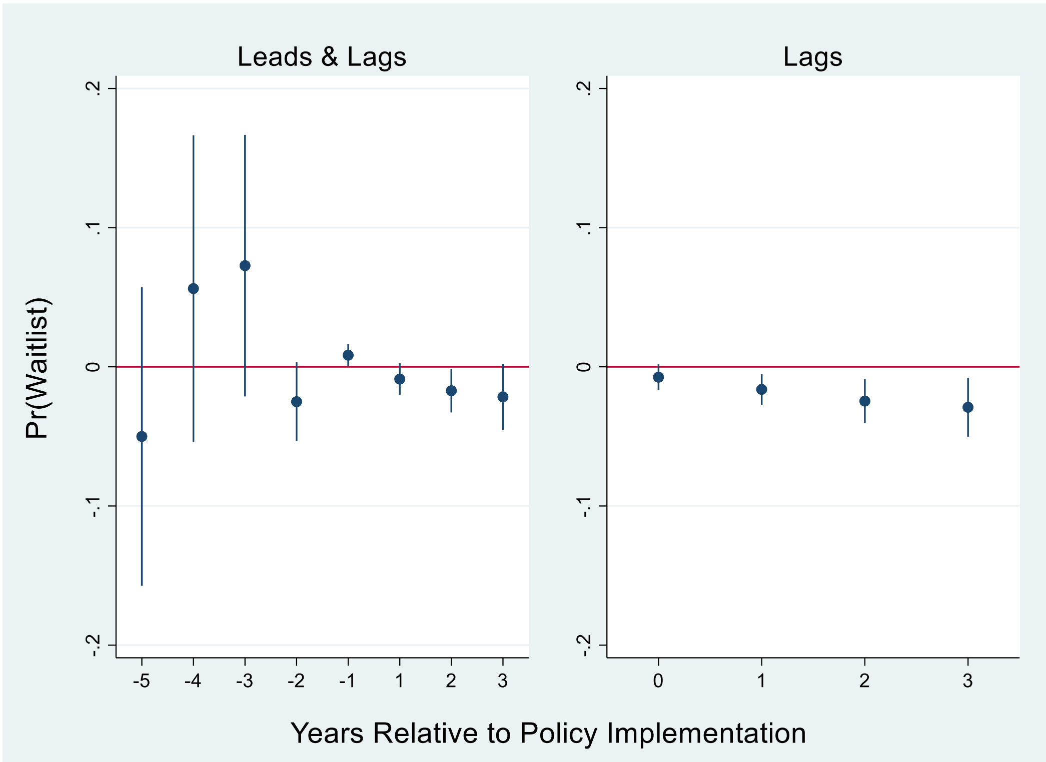

Figure 8: Effect of Pilot Policy on Pr(Waitlisting)

Notes: Graphs plot coefficients of interactions between policy leads and lags and treatment status with 95% confidence intervals. These coefficients were generated by regressions the probability of waitlisting on policy leads and lags, independently and interacted with treatment status, controlling for age, gender, race/ethnicity, major disease category (diabetes, glomerular, other) and center and year fixed effects. For centers in the CAOP and MIOP donation service areas and the untreated group, the policy change occurs on 4/29/2006 (t=0). For patients receiving transplants at centers in the IAOP, treatment (t=0) occurs on 1/24/2007. Confidence intervals are based on standard errors clustered at the center level.

Table A4 shows regression results for the probability of waitlisting for this same sample of all individuals with end-stage renal disease who started dialysis between 1/1/2000 and 12/31/2009 and for samples restricted to individuals who died before 10/19/2020 and omitting the commercial insurance variable, which decreased our sample size substantially. Overall, patients beginning dialysis after the policy change are 1.5 percentage points less likely to waitlist and this effect is even greater among those for whom insurance information is not reported.

To sum up our overall results, we have now documented an overall delay in pre-waitlist dialysis time. With regard to waitlist outcomes, we find a decreased likelihood of deceased donor transplantation (accompanied by an increased likelihood of live donor transplantation) and possibly an increase in the likelihood of being delisted as too sick for transplant. We do not, however, identify any significant changes in post-transplant outcomes or in the likelihood of waitlisting prior to beginning dialysis. Lastly, we show a decrease in the likelihood of waitlisting at all. To explore whether the policy differentially affected those most likely to have gained an improvement in access to transplantation, we now turn to analyze whether the results vary by race/ethnicity and insurance type.

Heterogeneous effects by race/ethnicity and payer type

We begin by establishing baseline differences in access by socioeconomic group to evaluate the validity of our proxies for reduced access based on socioeconomic status, with the results shown in Table A5 through A7. (Table A4 through A7 replicate the regressions underlying Tables 3 through 5, but report the coefficients on the socioeconomic variables.) The results show Blacks, Hispanics, and "Other" race/ethnicity groups access transplant care later than Non-Hispanic Whites and Asians. Similarly, those with non-private insurance access care later than those with private insurance. Waitlist and post-transplant outcomes are not consistently worse for certain races, but are consistently worse for those without private payers, suggesting this may be our best proxy for reduced access to and quality of healthcare. The fact that race/ethnicity appears to be a worse proxy for reduced access to healthcare could be related to cultural and religious issues specific to transplantation. Running the waitlist process regressions by our socioeconomic proxy variables, as shown in Table 8, yields the coefficients on the post-policy change variable shown in Panels A through C. These results indicate that the effect of the policy on delaying accessing of care is strongest among those already facing delayed access to care, i.e., blacks, Hispanics, and those with non-private insurance. Only Hispanics and private payers appear to experience reduced days on the waitlist with Hispanics, Asians, Other Races, and those with private payers experiencing a reduction in overall pre-transplant dialysis time.

Table 8: Waitlisting Process: Subsample Analyses

	White	Black	Hispanic	Asian	Other Races	Private Payer	Non-Private Payer
Panel A: Outcome = Ln(Pre-Waitlist Dialysis Time)							
Dialyzed after Policy Change	0.081*	0.157***	0.130**	0.123	0.125*	0.066	0.129***
	(0.042)	(0.056)	(0.050)	(0.079)	(0.070)	(0.049)	(0.049)
Observations	100,768	71,582	39,583	12,959	17,900	86,647	143,186
R-squared	0.113	0.140	0.130	0.146	0.146	0.095	0.084
Panel B: Outcome = Ln(Days on Waitlist)							
Dialyzed after Policy Change	-0.082	-0.001	-0.353***	-0.076	-0.101	-0.202***	-0.131*
	(0.055)	(0.065)	(0.071)	(0.078)	(0.082)	(0.069)	(0.074)
Observations	91,918	57,043	31,705	10,707	14,806	77,331	118,141
R-squared	0.054	0.072	0.078	0.107	0.093	0.094	0.083
Panel C: Outcome = Ln(Dialysis Time Pre-Transplant)							
Dialyzed after Policy Change	-0.064	-0.012	-0.315***	-0.181***	-0.192***	-0.176**	-0.115*
	(0.060)	(0.054)	(0.054)	(0.068)	(0.063)	(0.075)	(0.062)
Observations	49,909	28,508	15,888	5,319	7,352	43,568	58,089
R-squared	0.091	0.122	0.130	0.138	0.134	0.129	0.120

Notes: Each column represents a separate subsample and regression and each panel focuses on a different outcome. All regressions include age at waitlisting, gender, race/ethnicity, major disease category (diabetes, glomerular, and other), and year and center fixed effects, except that the regressions by race/ethnicity omit other racial/ethnic groups, and the regressions by insurance type do not include insurance type as a control. Standard errors are clustered at the center level. *** p<0.001, ** p<0.01, * p<0.05.

We explore further to see if there are negative consequences associated with the delays documented among blacks, Hispanics and those without private insurance. Table 9 shows the waitlist outcomes by race/ethnicity and payer type and Table 10 shows transplant outcomes for these subgroups.

Table 9: Waitlist Outcomes by Race/Ethnicity and Payer Type

	White	Black	Hispanic	Asian	Other Races	Private Payer	Non-Private Payer
Panel A: Outcome = Transplant							
Dialyzed after Policy Change	-0.002	0.012	-0.022	-0.085***	-0.090***	-0.006	-0.020
	(0.018)	(0.020)	(0.024)	(0.026)	(0.024)	(0.015)	(0.018)
Observations	92,358	57,189	31,851	10,733	14,840	77,684	118,554
R-squared	0.089	0.095	0.134	0.165	0.148	0.108	0.089
Panel B: Outcome = Deceased Donor Transplant							
Dialyzed after Policy Change	-0.028	-0.010	-0.058**	-0.111***	-0.114***	-0.031	-0.054***
	(0.018)	(0.024)	(0.025)	(0.023)	(0.023)	(0.019)	(0.018)
Observations	92,358	57,189	31,851	10,733	14,840	77,684	118,554
R-squared	0.072	0.082	0.099	0.133	0.114	0.082	0.080
Panel C: Outcome = Live Donor Transplant							
Dialyzed after Policy Change	0.026*	0.022*	0.036*	0.026	0.025	0.025*	0.033**
	(0.015)	(0.013)	(0.020)	(0.020)	(0.019)	(0.014)	(0.013)
Observations	92,358	57,189	31,851	10,733	14,840	77,684	118,554
R-squared	0.075	0.051	0.106	0.091	0.083	0.086	0.054
Panel D: Outcome = Died							
Dialyzed after Policy Change	-0.028**	-0.007	-0.004	0.028	0.030	-0.008	-0.012
	(0.011)	(0.014)	(0.018)	(0.024)	(0.021)	(0.015)	(0.012)
Observations	92,358	57,189	31,851	10,733	14,840	77,684	118,554
R-squared	0.055	0.062	0.092	0.103	0.094	0.060	0.061
Panel E: Outcome = Too Sick							

Dialyzed after Policy Change	0.012	0.002	0.023***	-0.005	-0.004	0.012*	0.008
	(0.011)	(0.009)	(0.007)	(0.014)	(0.013)	(0.006)	(0.008)
Observations	92,358	57,189	31,851	10,733	14,840	77,684	118,554
R-squared	0.043	0.056	0.058	0.074	0.068	0.043	0.048

Notes: Each column represents a separate subsample and regression and each panel focuses on a different outcome. All regressions include age at waitlisting, gender, race/ethnicity, major disease category (diabetes, glomerular, and other), and year and center fixed effects, except that the regressions by race/ethnicity omit other racial/ethnic groups, and the regressions by insurance type do not include insurance type as a control. Standard errors are clustered at the center level. *** p<0.001, ** p<0.01, * p<0.05.

There appear to be negative consequences across racial and ethnic groups in terms of the likelihood of receiving a deceased donor transplant, but Hispanics appear to the be the group driving the results in the overall analysis – they delay waitlisting, experience a decreased probability of deceased donor transplant and an increased likelihood of being deemed too sick for transplant. Some of these negative effects among Hispanics may have been mitigated by the decrease in total dialysis time prior to transplant and a possible increase in live donor transplants.

Table 10: Transplant Outcomes by Race/Ethnicity and Payer Type

	White	Black	Hispanic	Asian	Other Races	Private Payer	Non-Private Payer
Panel A: Outcome = Dialysis within 1 week post-transplant							
Dialyzed after Policy Change	-0.003	-0.010	-0.024	-0.050	-0.029	-0.039*	0.001
	(0.023)	(0.023)	(0.027)	(0.036)	(0.032)	(0.022)	(0.021)
Observations	49,876	28,445	15,864	5,317	7,349	43,529	58,005
R-squared	0.056	0.093	0.079	0.087	0.073	0.059	0.070
Panel B: Outcome = Died within 6 months							
Dialyzed after Policy Change	0.004	0.007	-0.038**	-0.020	-0.035	-0.012	-0.007
	(0.012)	(0.016)	(0.019)	(0.026)	(0.022)	(0.009)	(0.014)
Observations	45,461	26,255	14,104	4,795	6,603	39,384	53,039
R-squared	0.018	0.027	0.034	0.057	0.052	0.018	0.019
Panel C: Outcome = Died within 1 year							

Dialyzed after Policy Change	-0.008	0.014	-0.019	0.007	0.000	-0.003	-0.008
	(0.013)	(0.016)	(0.020)	(0.048)	(0.036)	(0.010)	(0.015)
Observations	40,976	21,798	11,715	4,007	5,569	35,326	44,732
R-squared	0.030	0.035	0.054	0.099	0.086	0.032	0.030

Notes: Each column represents a separate subsample and each panel focuses on a different outcome. All regressions include age at waitlisting, gender, race/ethnicity, major disease category (diabetes, glomerular, and other), and year and center fixed effects, except that the regressions by race/ethnicity omit other racial/ethnic groups, and the regressions by insurance type do not include insurance type as a control. Standard errors are clustered at the center level. *** p<0.001, ** p<0.01, * p<0.05.

Lastly, we present results on how the probability of waitlisting varies using the USRDS data as shown in Table 11, finding a similar pattern – those patients for whom access increased the most appear to delay access the most, Black, Hispanics and patients with non-private payers reduced their likelihood of ever waitlisting with the policy change.

Table 11: Effect of Policy Change on Ever Waitlisting by Race/Ethnicity and Payer Type

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	White	Black	Hispanic	Asian	Other Race	Private Payer	Non-Private Payer
Dialyzed after Policy Change	-0.011	-0.014**	-0.021***	-0.020**	0.007	-0.006	-0.019***
	(0.008)	(0.006)	(0.007)	(0.009)	(0.031)	(0.010)	(0.004)
Constant	0.489***	0.546***	0.698***	0.648***	0.722***	0.735***	0.495***
	(0.043)	(0.083)	(0.076)	(0.068)	(0.186)	(0.040)	(0.057)
Observations	296,603	159,672	74,904	25,125	6,974	154,240	404,508
R-squared	0.130	0.115	0.116	0.210	0.153	0.099	0.060

Notes: Sample includes all individuals who started dialysis between 1999 and 2010. The regression in column (1) includes age at dialysis inception, gender, race/ethnicity, major disease category (diabetes, glomerular, and other), and year and state fixed effects. Columns (1) to (5) omit the race/ethnicity variables and Columns (6) and (7) omit the payer variables. Standard errors are clustered at the state level. *** p<0.001, ** p<0.01, * p<0.05.

Tables A8-A11 report results from our robustness check confirming the delays in waitlisting found our overall sample results omitting the years 2004 through 2007, both for the UNOS and USRDS data. The results are consistent with the main results.

VI. DISCUSSION

In line with the predictions from the theoretical framework, our empirical results document that the switch from wait-time to the maximum of wait-time and dialysis time led to delays in the timing of waitlisting for kidney transplantation among patients on dialysis. These delays were most pronounced among those already more likely to delay care, the socioeconomically disadvantaged, as proxied by race/ethnicity and insurance status. We further document negative effects from this delay. For those who waitlist after initiating dialysis, our findings suggest a decrease in the availability of deceased donors, a possible increase in the likelihood of being deemed too sick for transplant, and a decrease in the probability of ever waitlisting at all. We do not, however, find any negative effects on post-transplant outcomes. Extending our analysis, we show no decrease in the probability of waitlisting *before* beginning dialysis, but we do document a decrease in the number of deceased donors available for these patients, too, as a result of the policy change. It is worth noting that the negative downstream effects on delisting and post-transplant outcomes may be underestimated, because some patients who began dialysis during our sample period have not yet been delisted and this may be the subgroup who delays the most, and therefore, likely experiences the most severe consequences of the policy change. Two other factors also could be working to diminish the negative effects of delaying waitlisting. First, it appears that the policy was effective at improving waitlist management and reducing the total time on dialysis prior to transplant, which could counteract some of the negative impact of the policy on post-transplant outcomes. (H.-U. Meier-Kriesche & Schold (2005) shows that pre-transplant dialysis time is a negative factor for post-transplant outcomes.) Second, we see a shift towards increased live donor transplants, which tend to be associated with better post-transplant outcomes (Kanellis, 2010).

Our theoretical model and supporting results caution against a potential unintended consequence of policies designed to increase access to care by reducing the costs of accessing care. With the reduction in the costs of delaying accessing care, the average individual waitlisting for kidney transplantation delayed 11.6% longer or about 76 days (from a mean of 652 days), a significant amount of time, especially for more quickly progressing diseases. Furthermore, it seems that these effects are largely driven by the very groups such access-increasing policies are designed to benefit. Our results are also relevant to the many efforts to increase donation from informational interventions to kidney exchanges, because the same factors limiting access to healthcare more generally limit the ability of a live donor to donate and the likelihood that an otherwise eligible donor will die in a hospital, as generally required for viable deceased organ donation.

Our predictions are general enough to extend beyond transplantation to the many contexts involving significant wait-times, predicting similar delays in accessing care will arise when the benefits of accessing care in advance of treatment are reduced. Long waiting periods to obtain medical care are quite common even when a formal waitlisting process does not exist and always require patients to make tradeoffs between the costs and benefits of obtaining care at a given moment, which determines the timing of accessing care. However, our empirical results may have limitations in terms of generalizability because we use data from kidney transplantation, with kidney disease progressing slowly enough that many individuals can survive for years and even decades on dialysis. Essentially, dialysis offers an alternative treatment option with live donors offering an even better substitute for deceased donor transplantation. For more quickly progressing diseases than kidney disease or where alternative treatment options are not readily available, delays might lead to more severe consequences for treatment outcomes. In contexts in which delays are more likely to be associated with discomfort than death, individuals may delay seeing a healthcare provider even longer. If, as in our study, those most likely to delay are those already disadvantaged in terms of access, disparities in which patients obtain health care could be further exacerbated.

VII. CONCLUSION

This study provides a theoretical mechanism through which individuals given improved access to care may respond by delaying accessing that care. We empirically document precisely such effects using data from kidney transplantation. The delay in waitlisting suggests a decrease in pre-transplant care obtained through transplant centers and may also suggest decreased health investment more broadly due to the increased ease of obtaining a transplant. The policy studied herein was extended to the rest of the U.S. in 2014, but the long-term effects of this policy change on a national level remain unknown. Our model and empirical results suggest that the new kidney allocation algorithm likely increases delays in waitlisting by patients on dialysis and may even cause some to never waitlist at all.

Studies of behavioral distortions induced by policy changes are inherently specific to the policy change and the affected sector, making them typically internally valid but difficult to generalize to other contexts. Nevertheless, the findings in the current study provide evidence for a particular type of behavioral distortion – access to care leads to delays in accessing care – in the context of kidney transplantation. These findings add to a broader discussion about the effect of improving access to health care. While conventional wisdom suggests that improved access to care would lead to improved health outcomes, empirical studies have found mixed evidence in various contexts (e.g. Baicker et al., 2013; De La Mata, 2012; Grecu & Sharma, 2019; M. Li & Baughman, 2010), including a study of a closely related population, which found an increase in

BMI among diabetics following state-level insurance mandates (Klick and Stratmann 2007). Findings in the current study point to a potential explanation for this discrepancy in the literature: the benefits of improved access to care may be outweighed by behavior distortions that worsen health outcomes.

To develop generalizable policy recommendations associated with the behavioral distortions documented in this paper, further research is needed regarding delays in accessing care in response to increased access-to-care in other contexts, particularly those where prior care is no care (rather than dialysis care) and when conditions progress more quickly. For example, delays in accessing emergency room care, prenatal care, cardiac and cancer care, and even dialysis could lead to sizeable differences in treatment outcomes.

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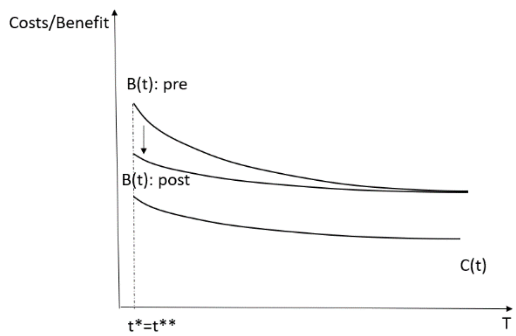
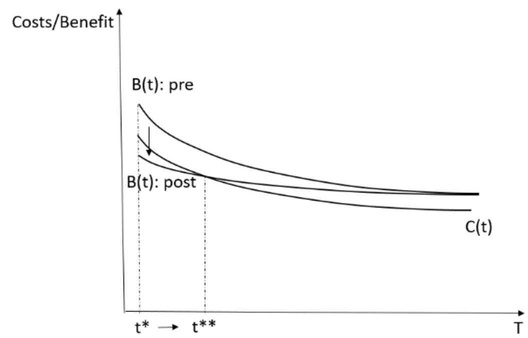
APPENDIX

A. Theoretical Framework – Alternative Scenarios

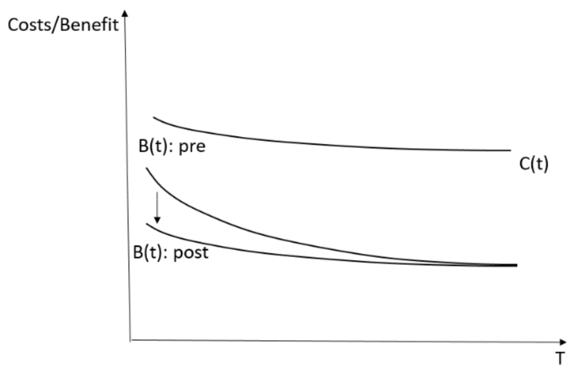
1) The benefit of waitlisting exceeds costs at the time of diagnosis





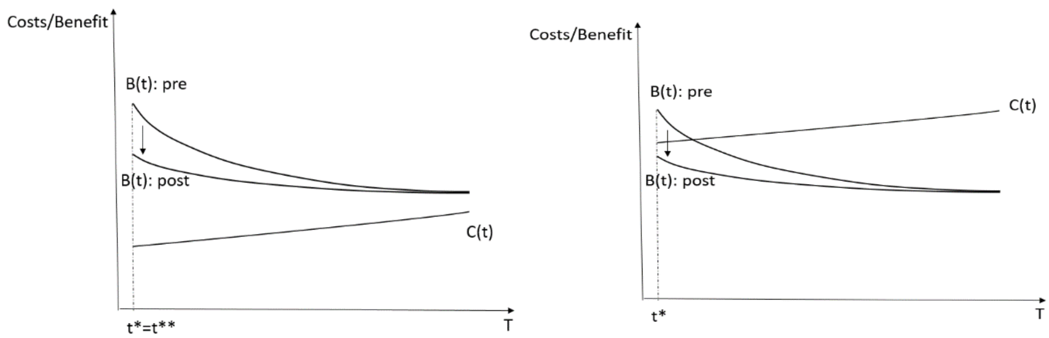
If the benefit of waitlisting exceeds costs at the time of dialysis, patients would choose to waitlist immediately after diagnosis. The policy change, which decreases the benefit of early waitlisting, would have no impact on waitlisting timing (left) or delay waitlisting (right).

2) The costs of waitlisting always exceed the benefit



If the costs of waitlisting always exceed benefits, patients would not choose to waitlist but would rely on other treatment methods. The policy change would not affect the waitlisting decision.

3) The costs of waitlisting increase over time, but do not always exceed the benefit



If the cost curve of waitlisting is upward slopping (this may be the case if medical costs to maintain suitability for transplant rises over time), patients would choose to waitlist immediately after diagnosis. The policy change would not affect waitlisting timing if a patient ever waitlists (left), or would increase the probability of never waitlist (right).

B. Tables

Table A1: Comparing Outcomes between Untreated with Treated Centers Prior to the Policy Change

	Untreated	Treated	P-Value
	No Policy Change Pre-4/29/2006	Pre-Policy Change	Untreated v. Treated Pre-Policy Change
<u>Waitlist Process Outcomes</u>			
Pre-waitlist dialysis time (days)	710	726	0.007
Ln(pre-waitlist dialysis time in days)	6.02	6.07	<0.001
Days on waitlist prior to delisting	786	899	<0.001
Ln(days on waitlist prior to delisting)	6.14	6.25	<0.001
Days on dialysis prior to transplant	1239	1517	<0.001
Ln(days on dialysis prior to transplant)	6.83	7.03	<0.001
<u>Waitlist Outcomes</u>			
Received transplant	0.55	0.51	<0.001
Received deceased donor transplant	0.43	0.37	<0.001
Received live donor transplant	0.12	0.14	<0.001
Died on waitlist	0.18	0.17	0.001
Deemed too sick for transplant	0.06	0.07	<0.001
<u>Post-Transplant Outcomes</u>			
Dialysis within the first week post-transplant	0.21	0.23	<0.001
Died within 6 months	0.07	0.09	<0.001
Died within 1 year	0.1	0.10	0.169
<u>Decision to Waitlist</u>			
Preemptively waitlisted	0.07	0.07	<0.001
Waitlisted	0.10	0.31	<0.001
Waitlisted Prior to Death	0.25	0.14	<0.001

Notes: The "Untreated" sample are those patients waitlisted at transplant centers that did not change their waitlisting policies. The "Treated" sample includes those patients waitlisted at centers that switched from waitlisted time to dialysis time. P-values are from two-sided t-tests for continuous variables and from chi-squared tests for dichotomous variables.

Table A2: Comparing Patient Populations between Untreated and Treated Centers

	Untreated	Treated	P-Value	Treated	P-Value
	No Policy Change	Pre-Policy Change	Untreated v. Treated Pre-Policy Change	Post-Policy Change	Treated Pre- v. Post-
Socioeconomic Status Proxy Variables					
White	0.47	0.36	<0.001	0.36	0.624
Black	0.31	0.22	<0.001	0.20	0.005
Hispanic	0.14	0.32	<0.001	0.32	0.277
Asian	0.05	0.09	<0.001	0.10	<0.001
Other race	0.07	0.10	<0.001	0.11	0.005
Private payer	0.39	0.40	0.222	0.43	<0.001
Control Variables					
Male	0.6	0.61	0.066	0.63	0.001
Age at waitlisting	49.02	48.78	0.011	49.61	<0.001
Diabetes	0.34	0.36	<0.001	0.38	0.001
Glomerular Disease	0.22	0.23	<0.001	0.23	0.785

Notes: The "Untreated" sample are those patients waitlisted at transplant centers that did not change their waitlisting policies. The "Treated" sample includes those patients waitlisted at centers that switched from waitlisted time to dialysis time. P-values are from a chi-squared test for dichotomous variables and from two-sided t-tests for continuous variables.

Table A3: Event Studies Comparing Full Treatment Leads and Lags with Treatment Lags Only

Outcome=Ln(Pre-Waitlist Dialysis Time)		
Interaction Coefficients		
t=-5	-0.029	
	(0.075)	
t=-4	-0.061	
	(0.073)	
t=-3	-0.133**	
	(0.061)	
t=-2	-0.072	
	(0.049)	
t=-1	-0.112**	
	(0.049)	
t=0	Ref.	Ref.
t=1	0.048	0.129**
	(0.068)	(0.052)
t=2	0.045	0.126**
	(0.067)	(0.055)
t=3	0.127**	0.209***
	(0.059)	(0.045)
Constant	5.558***	5.517***
	(0.039)	(0.061)
Observations	201,036	201,036
R-squared	0.148	0.147

Notes: Each column represents a separate regression. The reported coefficients are estimates of the effects of interactions between policy leads and/or lags only and whether or not the center participates in the policy change, i.e., they measure the effect of being in that time period for centers who will or who have implemented the pilot policy relative to the centers which never implement the policy. For centers in the CAOP and MIOP donation service areas and the untreated group, the policy change occurs on 4/29/2006 (t=0). For patients waitlisting at centers in the IAOP, treatment (t=0) occurs on 1/24/2007. Both regressions include age at waitlisting, gender, major disease category (diabetes, glomular, and other), and waitlist year and center fixed effects. Standard errors are clustered at the center level. *** p<0.001, ** p<0.01, * p<0.05.

Table A4: Decision to Waitlist – Regression Analysis

VARIABLES	(1) Overall	(2) Died Prior to 10/19/2012	(3) Omitting Insurance Variable
Dialyzed after Policy Change	-0.015***	-0.015***	-0.030***
	(0.005)	(0.003)	(0.005)
Constant	0.493***	0.351***	0.201***
	(0.039)	(0.074)	(0.006)
Observations	558,748	310,822	1,095,244
R-squared	0.131	0.048	0.071

Notes: Sample includes all individuals who started dialysis between 1999 and 2010. The regression in column (1) includes age at waitlisting, gender, race/ethnicity, major disease category (diabetes, glomerular, and other), and year and center fixed effects. Columns (2) to (5) omit the race/ethnicity variables and Columns (6) and (7) omit the payer variables. Standard errors are clustered at the center level. *** p<0.001, ** p<0.01, * p<0.05.

Table A5: Waitlist Process Outcomes Reporting Effects Socioeconomic Proxy Variables

Outcome:	(1) Ln(Pre-Waitlist Dialysis Time)	(2) Ln(Days on Waitlist)	(3) Ln(Dialysis Time Pre-Transplant)
Dialyzed after Policy Change	0.110***	-0.158**	-0.143**
	(0.036)	(0.065)	(0.063)
Black	0.388***	0.413***	0.442***
	(0.012)	(0.012)	(0.012)
Hispanic	0.265***	0.266***	0.280***
	(0.016)	(0.016)	(0.017)
Asian	-0.069***	0.020	0.039
	(0.021)	(0.035)	(0.028)
Other Race	0.268***	0.330***	0.313***
	(0.020)	(0.031)	(0.025)
Private Payer	-0.587***	-0.062***	-0.320***
	(0.023)	(0.010)	(0.011)
Constant	5.431***	5.623***	6.343***
	(0.031)	(0.038)	(0.025)
Observations	229,833	195,472	101,657
R-squared	0.146	0.085	0.156

Notes: Each column represents a separate regression with the outcomes listed in the column titles. The regression in the first column includes all waitlisted patients; the regression in columns (2) includes all patients waitlisted who were removed from the waitlist during our sample period and the last column includes only patients who received transplants. The omitted categories are white and non-private payer. All regressions include age at waitlisting, gender, major disease category (diabetes, glomular, and other), and year and center fixed effects. Standard errors are clustered at the center level. *** p<0.001, ** p<0.01, * p<0.05.

Table A6: Waitlist Outcomes Reporting Effects of Socioeconomic Status Proxy Variables

	(1)	(2)	(3)	(4)	(5)
Delisting Reason:	Transplant	Deceased Donor Transplant	Live Donor Transplant	Died on Waitlist	Too Sick for Transplant
Dialyzed after Policy Change	-0.015	-0.045***	0.030***	-0.010	0.011*
	(0.013)	(0.015)	(0.011)	(0.011)	(0.006)
Black	-0.027***	0.044***	-0.071***	-0.000	0.016***
	(0.005)	(0.004)	(0.003)	(0.003)	(0.002)
Hispanic	0.028***	0.038***	-0.010**	-0.032***	0.007***
	(0.005)	(0.006)	(0.004)	(0.004)	(0.002)
Asian	0.041***	0.064***	-0.023***	-0.036***	-0.008
	(0.013)	(0.013)	(0.008)	(0.009)	(0.005)
Other Race	-0.026**	0.002	-0.029***	-0.006	0.004
	(0.011)	(0.011)	(0.007)	(0.006)	(0.004)
Private Payer	0.078***	0.008*	0.070***	-0.045***	-0.019***
	(0.004)	(0.004)	(0.003)	(0.004)	(0.002)
Constant	0.732***	0.403***	0.329***	0.007	-0.069***
	(0.015)	(0.012)	(0.010)	(0.009)	(0.007)
Observations	196,238	196,238	196,238	196,238	196,238
R-squared	0.099	0.077	0.078	0.061	0.047

Notes: Each column represents a separate regression with the outcomes listed in the column titles. The sample includes all patients who began dialysis between 1/1/2000 and 12/31/2009, waitlisted for transplant, and were delisted before 09/30/2013. The omitted categories are white and non-private payer. All regressions include age at waitlisting, gender, major disease category (diabetes, glomular, and other), and year and center fixed effects. Standard errors are clustered at the center level. *** p<0.001, ** p<0.01, * p<0.05.

Table A7: Transplant Outcomes Reporting Effects of Socioeconomic Status Proxy Variables

	(1)	(2)	(3)
VARIABLES	Pr(Dialysis within 1st week post-transplant)	Pr(Died within 6 months)	Pr(Died within year)
Dialyzed after Policy Change	-0.016	-0.009	-0.005
	(0.017)	(0.010)	(0.011)
Black	0.094***	0.014***	0.003
	(0.005)	(0.003)	(0.003)
Hispanic	0.016***	-0.006*	-0.022***
	(0.005)	(0.003)	(0.003)
Asian	-0.010	-0.008	-0.014
	(0.011)	(0.008)	(0.008)
Other Race	0.029***	0.003	-0.012
	(0.010)	(0.008)	(0.008)
Private Payer	-0.036***	-0.023***	-0.016***
	(0.003)	(0.002)	(0.002)
Constant	0.043***	0.102***	0.007
	(0.011)	(0.007)	(0.007)
Observations	101,534	92,423	80,058
R-squared	0.074	0.017	0.029

Notes: Each column represents a separate regression with the outcomes listed in the column titles. The sample includes all patients who began dialysis between 1/1/2000 and 12/31/2009, waitlisted for transplant, and received a transplant before 9/23/2013 in Column 1, before 3/30/2013 in Column 2, and before 9/30/2012 in Column 3. The omitted categories are white and non-private payer. All regressions include age at waitlisting, gender, major disease category (diabetes, glomular, and other), and year and center fixed effects. Standard errors are clustered at the center level. *** p<0.001, ** p<0.01, * p<0.05.

Table A8: Waitlist Process Outcomes Omitting 2004-2007

Outcome:	(1) Ln(Pre-Waitlist Dialysis Time)	(2) Ln(Days on Waitlist)	(3) Ln(Dialysis Time Pre-Transplant)
Dialyzed after Policy Change	0.128***	-0.193**	-0.166**
	(0.049)	(0.090)	(0.084)
Constant	5.388***	5.656***	6.319***
	(0.036)	(0.044)	(0.030)
Observations	133,171	112,833	59,233
R-squared	0.151	0.093	0.176

Notes: The sample is restricted to patients who began dialysis between 1/1/2000 and 1/1/2003 or between 1/1/2008 and 12/31/2009. Each column represents a separate ordinary least squares regression with the outcomes listed in the column titles. The regression in the first column includes all waitlisted patients; the regressions in columns (2) and (3) include all patients waitlisted who were removed from the waitlist during our sample period and the last column includes only patients who received transplants. All regressions include age at waitlisting, gender, major disease category (diabetes, glomular, and other), and year and center fixed effects. Standard errors are clustered at the center level. *** p<0.001, ** p<0.01, * p<0.05.

Table A9: Waitlist Outcomes Omitting 2004-2007

Delisting Reason:	(1) Transplant	(2) Deceased Donor Transplant	(3) Live Donor Transplant	(4) Died on Waitlist	(5) Too Sick for Transplant
Dialyzed after Policy Change	-0.022	-0.063***	0.041**	-0.003	0.011
	(0.019)	(0.021)	(0.016)	(0.012)	(0.009)
Constant	0.725***	0.404***	0.322***	-0.001	-0.054***
	(0.017)	(0.014)	(0.011)	(0.010)	(0.007)
Observations	113,325	113,325	113,325	113,325	113,325
R-squared	0.095	0.076	0.078	0.061	0.044

Notes: The sample is restricted to patients who began dialysis between 1/1/2000 and 1/1/2003 or between 1/1/2008 and 12/31/2009. Each column represents a regression using a linear probability model with the outcomes listed in the column titles. The omitted ethnic/race group is Non-Hispanic white. The regressions include all waitlisted patients who left the waitlist during our sample period. All regressions include age, gender, major disease category (diabetes, glomular, other) and year and center fixed effects. Standard errors are clustered at the center level. *** p<0.001, ** p<0.01, * p<0.05.

Table A10: Transplant Outcomes Omitting 2004-2007

	(1)	(2)	(3)
VARIABLES	Pr(Dialysis within 1st week post-transplant)	Pr(Died within six months)	Pr(Died within 1 years)
Dialyzed after Policy Change	-0.014	0.000	0.020
	(0.026)	(0.013)	(0.026)
Constant	0.052***	0.003	0.139***
	(0.012)	(0.008)	(0.034)
Observations	59,158	45,937	36,402
R-squared	0.075	0.029	0.053

Notes: The sample is restricted to patients who began dialysis between 1/1/2000 and 1/1/2003 or between 1/1/2008 and 12/31/2009. Each column represents a separate ordinary least squares regression with the outcomes listed in the column titles. Columns (2) through (4) are linear probability models. The regressions include only patients who received transplants. All regressions include age at waitlisting, gender, major disease category (diabetes, glomular, and other), and year and center fixed effects. Standard errors are clustered at the center level. *** p<0.001, ** p<0.01, * p<0.05.

Table A11: USRDS Decision to Waitlist Omitting 2004-2007

	(1)	(2)	(3)
VARIABLES	Overall	Died Prior to 10/19/2012	Omitting Insurance Variable
Dialyzed after Policy Change	-0.093**	-0.228***	-0.040***
	(0.039)	(0.036)	(0.009)
Constant	1.023***	0.676***	0.957***
	(0.040)	(0.069)	(0.022)
Observations	246,272	116,009	642,769
R-squared	0.263	0.138	0.258

Notes: Sample includes all individuals who started dialysis between 1/1/2000 and 12/31/2009, omitting anyone waitlisting between 1/1/2004 and 1/1/2007. The regression in column (1) includes age at waitlisting, gender, race/ethnicity, major disease category (diabetes, glomerular, and other), and year and center fixed effects. Columns (2) to (5) omit the race/ethnicity variables and Columns (6) and (7) omit the payer variables. Standard errors are clustered at the center level. *** p<0.001, ** p<0.01, * p<0.05.