Performance scores and Strategic Choices of Kidney Transplant Centers*

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Abstract

Does performance score affect a transplant center's strategic choices? To answer this question, we analyze the behavior of U.S. kidney transplant centers, where Medicare introduced Conditions of Participation (CoP), a performance score system, in 2007. Transplant centers are punished if their risk-adjusted death rate exceeds the threshold. Using a difference-in-difference framework, we do a before and after analysis based on the transplant center's distance from the performance threshold. We find that transplant centers reject transplants as they approach the threshold. The effect is most significant (22% less likely to do a transplant) at the threshold. We find that transplant centers are more likely to avoid medium/high-risk transplants than low-risk transplants as we approach the threshold. Secondly, we do not see any evidence to suggest performance scores improved transplanted patients' survival rates. Thirdly, low-volume centers are more likely to reject transplants than high-volume centers even before they approach the threshold. Contrary to previous literature, our results indicate that strategic behavior among transplant centers is more widespread than previously thought.

JEL codes: I11, I18, L38

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1 Introduction

Centers for Medicare and Medicaid Services (CMS) strives to enact policies that protect patient health and safety. One prominent effort to achieve this is the Conditions of Participation (CoP) program, which requires hospitals to report outcomes of patient operations every six months. Medicare uses this report to monitor and penalize poor performers after suitable risk adjustments. An advantage of this program is that it incentivizes improving service quality and patient outcomes. However, one drawback is hospitals ration health care under the guise of quality.

This paper examines a section of the U.S. healthcare market influenced by CMS CoP policy, the deceased donor kidney transplant program. We show that transplant centers disproportionately reject transplants due to performance concerns. As a result, patients on the waitlist are 22% less likely to receive a transplant and spend six more months on the waitlist than they would if there was no CoP.

Under CoP, transplant centers submit the outcomes of their transplanted patients to CMS. If the risk-adjusted death rate exceeds a threshold, centers are penalized and risk losing their certification. Since Medicare is the primary insurer for kidney transplants, such a ruling can close a transplant program (Hamilton, 2013). Previous interviews suggest that the threat of government penalties has made surgeons reject kidney offers when their performance deteriorates. For instance, a 2012 *New York Times* article described a conversation with the director of Columbia Hospital: "... if you have had a couple of bad outcomes recently you say, 'Well, why should I do this?'... You can always find a reason to turn organs down."(Sack, 2012).

Given the threat of decertification created by CMS's CoP, our paper examines the prevalence of strategic treatment in deceased donor kidney transplants. Using data on patient-kidney offers from 2003 to 2012, we provide evidence that transplant centers reject transplants as

they approach the threshold.

Literature Review: Previous papers by (Schold et al., 2014; Hamilton, 2013; White et al., 2015; Schold, 2020) document that transplant centers decrease transplant volume and admit healthier patients after CMS flagged them for poor performance. Based on the anecdotal evidence referenced above, we believe transplant centers are forward-looking and strategize to avoid crossing the threshold before the end of each six-month window. We believe the effect of CoP on center behavior is more widespread than previously thought.

2 Background and Institutional Settings

A patient diagnosed with end-stage renal disease (ESRD) has two options: dialysis or kidney transplant [1]. Kidney transplant is often cheaper and offers better quality of life in the long run, making it the preferred option (Matas and Schnitzler, 2004). In this study, we focus exclusively on deceased donor kidney transplants that account for 60% of all kidney transplants in the U.S. (AKF, 2003). This section describes the kidney allocation and transplant process and details of Conditions of Participation (CoP).

2.1 Kidney Allocation and Transplant Process

The Organ Procurement and Transplantation Network (OPTN) designs and administers the deceased donor kidney allocation process. When brain or cardiac death is imminent, hospitals upload a donor's medical history and organ condition into UNet. The system identifies biologically compatible patients and ranks them according to their priority order [2]. UNet simultaneously informs centers of all their patients compatible with the kidney to maintain organ viability [3](OPTN, 2023).

Centers have 1 hour to indicate their decision. Patients are only informed if the transplant center accepts the kidney offer[4]. The kidney offer goes to the highest priority patient accepted by the center. UNet removes the patient from the waitlist 24 hours after a successful transplant. In the case of a failed transplant, UNet returns the patient to the waitlist with the same priority (OPTN, 2023).

Centers discharge transplant patients within 3 - 5 days. Patients are offered immunosup-

[1]Dialysis is a treatment that removes waste and excess water from the blood. There are two types of dialysis: hemodialysis and peritoneal dialysis.

[2]UNet calculates priority by assigning higher weights to time spent on the waitlist and whether a patient is in the same donor service area (DSA).

[3]Centers are informed about their patient's ranking but do not observe the identity of other patients.

[4]Transplant centers only have 1 hour to make their decision, making it logistically impossible to notify every patient of the kidney offer. Furthermore, there are no regulations mandating transplant centers to inform patients of their kidney offers.

pressive drugs to prevent organ rejection. Patients are required to visit the transplant center for regular check-ups. The transplant center will inform UNet if the patient dies within 365 days after the transplant (OPTN, 2023).

2.2 Conditions of Participation (CoP)

Before July 2007, the OPTN was the primary organization responsible for monitoring transplant centers' performance [5] but only twice recommended to the Department of Health and Human Services to remove a transplant center's certification (Stith and Hirth, 2016). Center for Medicare and Medicaid Services (CMS) became concerned that the lack of severe penalties for poor performance may have led to a decline in the quality of kidney transplants. As stated in the Final Rule establishing the increase in CMS oversight:

> " The OPTN generally takes a collegial approach and assists the center in improving their performance, while we generally take a regulatory approach which sometimes may lead to termination ..." (CMS, 2007)

CMS introduced CoP in July 2007 to reduce post-transplant death and mitigate patient-kidney selection. Transplant centers must submit the 1-year survival of all their transplant operations in the past 2.5 years to the Scientific Registry of Transplant Recipients (SRTR) every six months (i.e., January - June, July - December). SRTR measures a center's performance by calculating the OE ratio: the ratio between observed failures (O) and expected failures (E)[6]. A transplant center has poor performance if all the following criteria are satisfied:

1. OE ratio = $\frac{\text{Observed failures (O)}}{\text{Expected failures (E)}} > 1.5$
2. 1 sided p-value = $\Pr(\text{O-E} \geq 0) < 0.05$

[5] The primary performance metric is the number of patient survival post-transplant.
[6] A failure is if the patient dies within 365 days after the transplant.

SRTR calculates the expected failure rate of each submitted patient-kidney pair by estimating a Cox proportional hazards model using various patient kidney characteristics. The 1-sided p-value describes the probability that the observed difference is due to chance. SRTR calculates the p-value by comparing the differences across all transplant centers in the U.S., accounting for the number of transplants by each center. The 5% critical value highlights Medicare's tolerance of misclassifying a center as underperforming.

Medicare flags a transplant center for poor performance if it fails to meet all the conditions above. Medicare then implements a data drive quality assessment and performance improvement (QAPI) system. If the transplant center is flagged again within the next 30 months, it risks losing its program certification and Medicare funding.[7].

[7]However, most transplant centers have 210 days to appeal that their poor performances are due to mitigating circumstances.

3 Data, Sample Selection and Descriptive Statistics

A primary contribution of our paper is to analyze how CoP changed transplant center behavior. The micro-level data we use in our analysis are essential for observing changes in a transplant center's strategic choices and how they subsequently affect patient outcomes. In this section, we describe our data, how to measure the distance to the CoP threshold, provide descriptive statistics for the most prominent features of the deceased donor market over our sample period, and discuss sample selection.

3.1 Data Sources

We draw information on the universe of patient kidney offers from the OPTN database from 2003 to 2012. Our primary data is the Potential Transplant Recipient (PTR) file. It contains all kidney offers made to a patient on the waitlist and documents when the kidney offer arrived, the final decision, reasons for rejection (if applicable), and the patient's ranking on the waitlist. We merge this data with the Standard Transplant Analysis and Research (STAR) file. It contains information on the patient's and deceased donor's demographics, health conditions, and immunological profile.

Our third dataset is the center-specific report (CSR) file. SRTR publishes CSR every six months, in June and December. Each CSR reports the transplant center's performance and activity within six months[8]. CSR also contains the statistical model and variables Medicare uses to calculate a transplant's expected death rate. We use this information in Section 3.2 to construct a distance measure to the CoP threshold. In the Appendix, we provide examples of CSR in Figure 8 and 9. We merged the three datasets to conduct our analysis at the patient-kidney offer level.

[8]For example, CSR reports the number of transplants, the number of patients on the waitlist, and the number of patients removed from the waitlist due to death.

3.2 Distance from CoP Threshold

CSR reports the transplant center's final OE score in June and December. To analyze the effect of CoP on center behavior, we construct a measure of distance to the CoP threshold between intervening kidney offers. We assume transplant centers are forward-looking and use the latest six-month window's CoP statistical model to forecast their OE score whenever they receive a kidney offer [9]. We call this the prevailing OE score, OE_{ck} for center c at kidney k. This measure is dynamic and increases whenever a past transplant fails between intervening kidney offers for center c [10].

After calculating OE_{ck}, we categorize observations based on their distance to the CoP threshold, 1.5. The assumption is transplant centers with OE_{ck} far from 1.5 are unlikely to exceed 1.5. Therefore, their incentives are the same before and after CoP. These observations are the control group. Conversely, transplant centers with OE_{ck} close to 1.5 face different incentives before and after CoP. These are in the treatment group.

Our main empirical specification in Section 4 defines the control group as $T_0 = \mathbb{1}\{OE_{ck} < 0.5\}$. We divide the remaining OE_{ck} into groups of 0.1, forming 14 treatment groups. For example, a treatment group m is $T_{m(ck)} = \mathbb{1}\{OE_{ck} \in [m-0.1, m)\}$ for all $m \in \{0.6, 0.7, ...1.9\}$.

Table 1 presents summary statistics for the patient-kidney offers of the control and treatment groups. We do not observe systematic differences in the medical or demographics information.

3.3 Summary Statistics

Figure 1 illustrates the significant change in the deceased donor market over our sample period of 2003 - 2012. First, the post-transplant death rate (solid lines) has dropped by five

[9] If a kidney offer comes in on 28th April 2008, OE_{ck} will be based on the statistical model released on 31st December 2007.

[10] This measure was motivated by conversations with surgeons who shared how their transplant center monitors performance after CMS introduced CoP

Table 1: Patient covariates summary statistics

	Control	Treatments
Panel A: Medical Information		
Body Mass Index (B.M.I)	27.02	26.97
	(5.630)	(6.000)
Expected Post Transplant Survival	31.28	30.67
	(29.24)	(29.36)
% Diabetic	28.05	27.72
	(44.93)	(44.76)
% On dialysis	72.38	70.75
	(44.71)	(45.49)
Panel B: Demographics		
Age	48.99	48.46
	(14.53)	(15.23)
% White	48.51	42.67
	(49.98)	(49.46)
% Have working income	17.69	15.78
	(38.16)	(36.46)
% Only High School	67.01	64.94
	(47.02)	(47.71)
% Completed Uni.	15.44	15.52
	(36.13)	(36.21)
% Medicare as primary insurer	60.40	60.70
	(48.91)	(48.84)
Years on Waitlist	3.974	4.329
	(3.543)	(3.876)
Observations	32081	244377

mean coefficients; sd in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

percentage points. Second, total transplants (dash lines) increased from 2003 to 2007 and stagnated before rising again in 2012. Although these patterns happened after CoP, other

factors could also explain these patterns. For instance, medical technology is improving over time, and surgeons are improving at treating and identifying bad transplants. A routine before and after CoP comparison of the deceased donor market is insufficient to determine the causal effect of CoP. Hence, it motivates the difference-in-differences research design in Section 4.

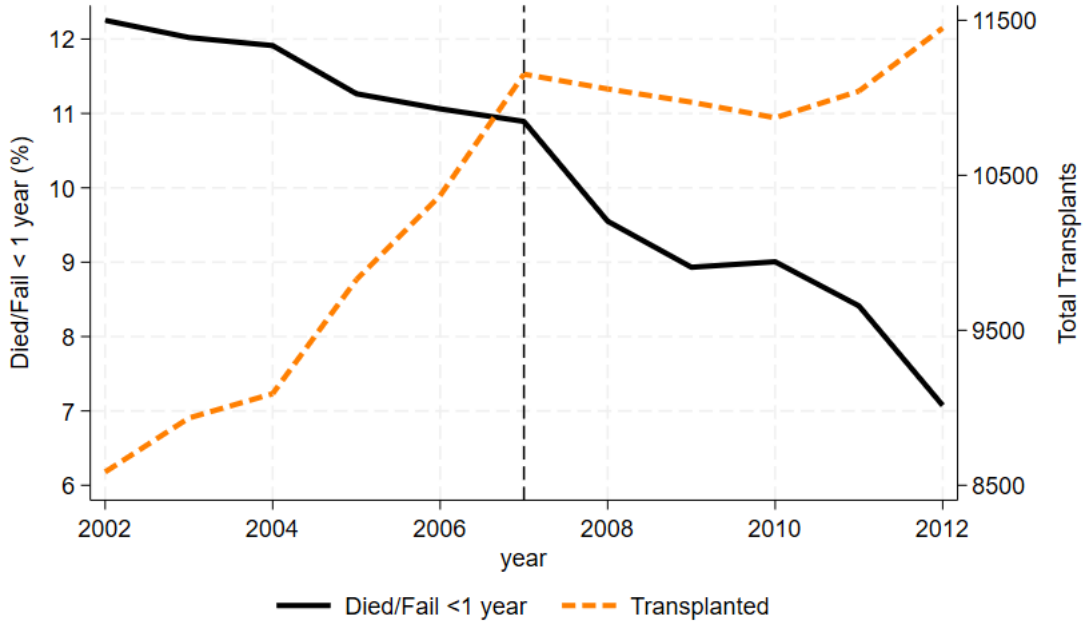


Figure 1: Post-transplant death rate and total transplants over 2003 - 2012.

Table 1 presents descriptive statistics at the patient-kidney offers level, split by $E[OE_{ck}]$ categories, to investigate the potential identification challenges we must address with our empirical strategy. Namely, the patient mix of the better performers may be inherently different from the worse performers. For instance, better performers may admit patients with better characteristics, or transplant centers may change their admission strategy when approaching the threshold.

Panels A and B show medical information and patient demographics for a subset of $E[OE_{ck}]$ categories, respectively. We do not observe systematic differences in the medical information or age for many of these attributes. Nevertheless, we consider the possibility that transplant

centers may admit healthier patients as they approach the threshold in Section 4.

4 Research Design Difference-in-differences

This section describes our research design and examines how CoP affects a transplant center's behavior and a patient's quality of care. Our research design is a difference-in-differences framework. We do a before and after analysis based on the transplant centers' distance from the CoP threshold. The baseline empirical specification is:

$$\begin{aligned} Y_{ick} = \alpha_0 + \sum_{m=0.6}^{1.9} \alpha_m \times T_{m(ck)} + \sum_{m=0.6}^{1.9} \beta_m \times T_{m(ck)} \times CoP_k \\ + \delta_t + \gamma_1 X_i + \gamma_2 Z_k + \varepsilon_{ik} \end{aligned} \tag{1}$$

Y_{ick} is the outcome of interest for patient i kidney k center c. As discussed in Section 3.2, $T_{m(ck)}$ indicates if center c is in treatment group m when kidney k arrives; δ_t is six-month period fixed effects and captures how Y_{ick} changes over time for the sample as a whole; CoP_k indicates if kidney k arrives after CoP; X_i and Z_k are characteristics of patient i and kidney k respectively and ε_{ick} is the error term. We cluster standard errors at the center level.

Our parameter of interest is β_m. Without center-fixed effects, we use the variation of Y_{ick} across centers in the same treatment group m and six-month period to identify β_m. For robustness checks, we include a center-fixed effect in our results.

4.1 Acceptance Behavior

We first consider the acceptance behavior of transplant centers since its impact is most direct on patient outcomes. We use the following subsample to estimate equation 1 when Y_{ick} indicates whether center c accepts kidney k for patient i.

First, we omit patient-kidney offers in 2007. The reason is that Medicare introduced CoP in July 2007. We want to avoid possible anticipatory behaviors before CoP and delayed reactions due to centers adjusting and learning about the new CoP policy. Secondly, we

only use the top 2 patient offers for each deceased donor. The reason is that humans have a pair of kidneys. The centers representing the top 2 patients make decisions that are not contingent on other centers' rejection and avoid concerns of observational learning that may attenuate the estimates of β_m (Zhang, 2010; de Mel et al., 2020).

Table 2 presents the results for a subset of β_m. Column (1) shows that transplant centers are less likely to accept a patient-kidney offer as we get closer to the threshold. Column (2) includes patient and kidney controls, while Column (3) adds center-fixed effects. In column (2), the probability of transplant drops by 6.38 percentage points at the threshold, which translates to a 22% drop compared to the control group.

Table 2: Effect of CoP on transplant center acceptance behavior

	(1)	(2)	(3)
$\beta_{0.7}$	0.0136*	0.00314	-0.0108
	(0.00686)	(0.00693)	(0.00716)
$\beta_{1.1}$	-0.0218**	-0.0387***	-0.0548***
	(0.00744)	(0.00754)	(0.00785)
$\beta_{1.5}$	-0.0662***	-0.0638***	-0.0680***
	(0.0105)	(0.0106)	(0.0109)
$\beta_{1.8}$	-0.0388**	-0.0446***	-0.0583***
	(0.0128)	(0.0129)	(0.0132)
Center FE			✓
6-months period FE	✓	✓	✓
Pat. and Kid. Controls		✓	✓
Observations	246607	232825	232824

Standard errors in parentheses

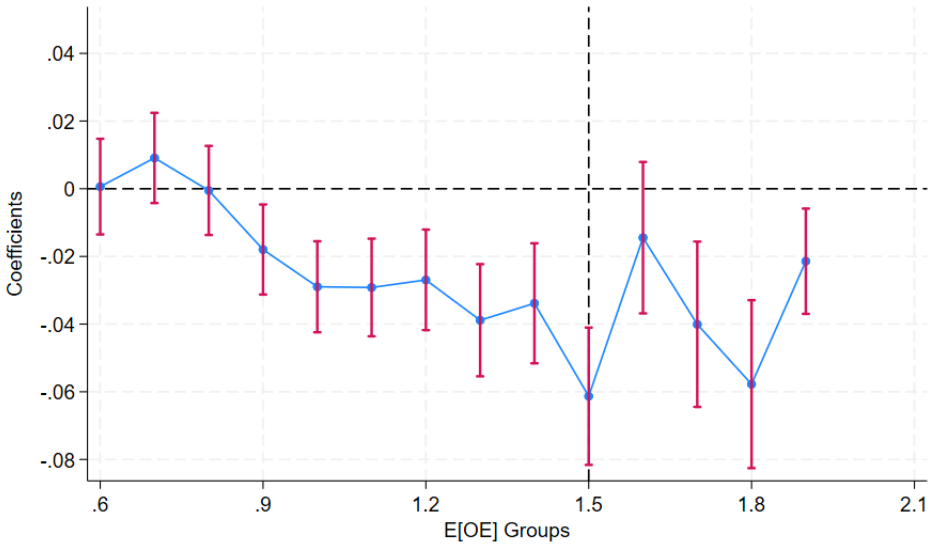
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: An observation is a patient-kidney offer. The dependent variable is an indicator for accepting the kidney offer for the patient. We restrict the sample to the top 2 patients of each deceased donor from 2003 - 2006 and 2008 - 2012. We cluster standard errors at the center level.

I plot the full range of β_m from Column (2) in Figure 2. Transplant centers are less likely to accept a kidney offer as their OE score approaches the CoP threshold. The decrease

is most significant at $m = 1.5$. The pattern persists even as we cross the threshold. The results suggest that transplant centers are forward-looking and consider their OE scores when deciding to accept the kidney offer for the patient.

Figure 2: Acceptance behavior across different OE_{ck} groups



Note: The figure shows the acceptance behavior for each OE group m after CoP. We plot the OLS estimates and 95% confidence intervals of the coefficients β_m from equation 1. We cluster standard errors at the center level.

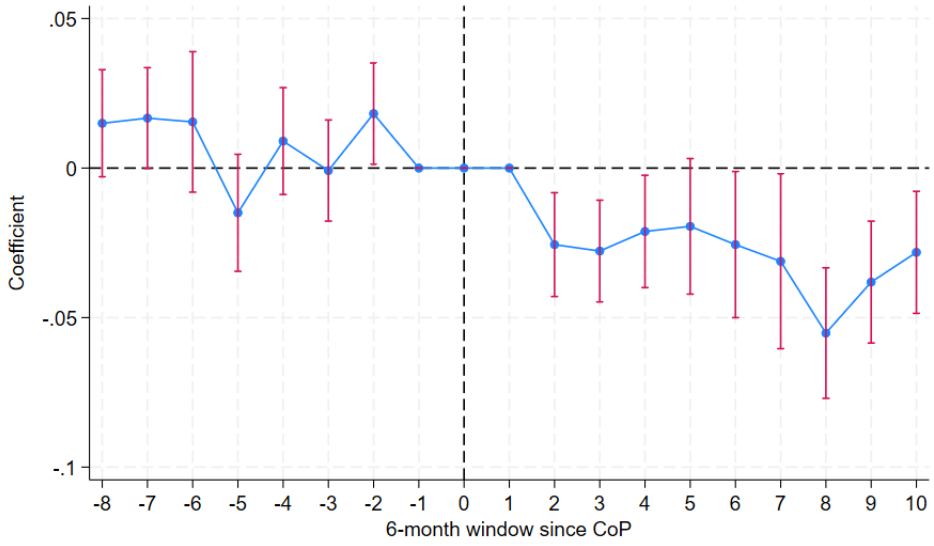
To interpret this estimate as the causal effect of CoP, we assume that CoP created a discontinuous change in center behavior and that any trends between the treatment and control groups are parallel in the absence of CoP. To support the parallel trends assumption, we estimate the following events-study specification:

$$\begin{aligned} Accept_{ick} = \alpha_0 + \alpha \times T_{-0} + \sum_{s=-8, s\neq -1}^{10} \beta_{t-s} \times T_{-0} \times \delta_{t-s} \\ + \sum_{s=-8, t\neq 1}^{10} \delta_{t-s} + \gamma_1 X_i + \gamma_2 X_k + \varepsilon_{ik} \end{aligned} \tag{2}$$

We group all the treatment groups together and define $T_{-0} = \mathbb{1}\{OE_{ck} \geq 0.5\}$. The coefficient

β_{t-s} measures the differential impact of CoP on the acceptance behavior of the treatment group relative to the control group. s measures the six-month periods relative to CoP implementation in July 2007. We plot the β_{t-s} coefficients in Figure 3 and find no evidence of pre-trends in acceptance behavior.

Figure 3: Acceptance behavior dynamic for T_{-0}



Note: The figure shows OLS estimates and 95% confidence intervals of the coefficients β_t form equation 2. We plot all coefficients relative to when CMS introduced CoP (t=0). We cluster standard errors at the center level.

4.1.1 Differences by risk profiles

Next, I extend the baseline specification to investigate if the effect of CoP on acceptance behavior differs by risk profiles. In my sample, I use information on patient risk to categorize patients into low and high risk. I follow a similar procedure for kidneys. Then, I group patient-kidney offers into low, medium, and high-risk transplants [11]. The regression equation

[11] Low-risk transplants are patient-kidney offers that are both low-risk. High-risk transplants are patient-kidney offers that are both high-risk. Medium-risk transplants are the remaining patient-kidney offers.

in this case is:

$$
\begin{aligned}
Y_{ik} = & \sum_{r=med,high} \alpha_r \times R_{r(ik)} + \sum_{m=0.6}^{1.9} \alpha_m \times T_{m(ck)} \\
& + \sum_{r=med,high} \gamma_r \times R_{r(ik)} \times CoP_k + \sum_{m=0.6}^{1.9} \gamma_m \times CoP_k \times T_{m(ck)} \\
& + \sum_{r=med,high} \sum_{m=0.6}^{1.9} \gamma_{mr} \times T_{m(ck)} \times R_{r(ik)} \\
& + \sum_{r=med,high} \sum_{m=0.6}^{1.9} \beta_{mr} \times CoP_k \times T_{m(ck)} \times R_{r(ik)} \\
& + \sum_{t=1}^{20} \delta_t + \gamma_1 X_i + \gamma_2 Z_k + \varepsilon_{ick}
\end{aligned} \tag{3}
$$

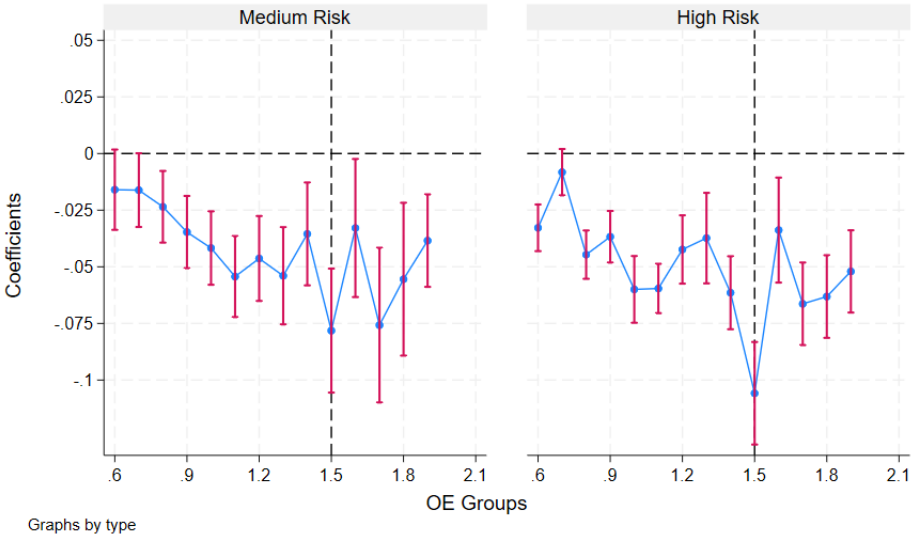
We have a triple difference-in-differences equation where we interact $R_{r(ik)}$, the risk indicator for patient i, kidney k with CoP_k and $T_{m(ck)}$. The omitted group for $R_{r(ik)}$ is low-risk transplants. Our parameter of interest is β_{mr} and measures the differential impact of CoP on the acceptance behavior of risk group r relative to the low-risk group. We plot the coefficients of β_{mr} in Figure 4.

We see that as OE scores approach the threshold, transplant centers are less likely to accept a medium/high-risk transplant than a low-risk one. The decrease is most significant at $m = 1.5$ for both risk types. The pattern persists even as we cross the threshold.

4.1.2 Differences by center size

Next, we use a similar specification to equation 3 to investigate if the effect of CoP on acceptance behavior differs by center size. The intuition is that OE scores are noisy estimates of transplant center performance. Some centers have a higher standard error due to the low volume of transplants.

Figure 4: Acceptance behavior between different risk groups



Note: The figure shows the acceptance behavior for each risk group r after CoP. We plot the OLS estimates and 95% confidence intervals of the coefficients β_{mr} from equation 3. We cluster standard errors at the center level.

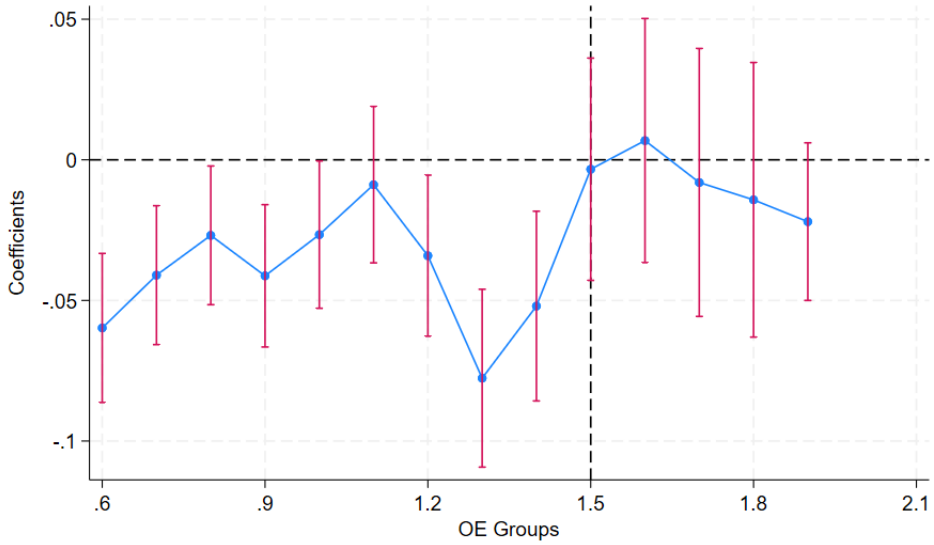
We categorize transplant centers into low and high-volume centers based on the number of transplants they perform every six months from 2003 - 2012. We regard transplant centers below the median number of transplants as low-volume centers. The regression equation in this case is:

$$\begin{aligned} Y_{ick} = \alpha \times LV_c + \sum_{m=0.6}^{1.9} \alpha_m \times T_{m(ck)} \\ + \gamma \times LV_c \times CoP_k + \sum_{m=0.6}^{1.9} \gamma_m \times CoP_k \times T_{m(ck)} \\ + \sum_{m=0.6}^{1.9} \delta_m \times T_{m(ck)} \times LV_c \\ + \sum_{m=0.6}^{1.9} \beta_m \times CoP_k \times T_{m(ck)} \times LV_c \\ + \sum_{t=1}^{20} \delta_t + \gamma_1 X_i + \gamma_2 Z_k + \varepsilon_{ick} \end{aligned} \tag{4}$$

We have a triple difference-in-differences equation where we interact LV_c, the indicator for low-volume centers, with CoP_k and $T_{m(ck)}$. Our parameter of interest is β_m and measures the differential impact of CoP on the acceptance behavior of low-volume centers relative to high-volume centers. We plot the coefficients of β_m in Figure 5.

Before OE scores approach the threshold, low-volume centers are less likely to accept a patient-kidney offer than high-volume centers. However, the difference is not statistically significant once we reach or cross the threshold. The result differs from previous results where the effect of CoP is the greatest at the threshold. Low-volume centers seem more sensitive to CoP than high-volume centers before the threshold.

Figure 5: Acceptance behavior for low-volume centers compared to high-volume centers



Note: The figure shows the acceptance behavior for low-volume centers after CoP. We plot the OLS estimates and 95% confidence intervals of the coefficients β_m from equation 4. We cluster standard errors at the center level.

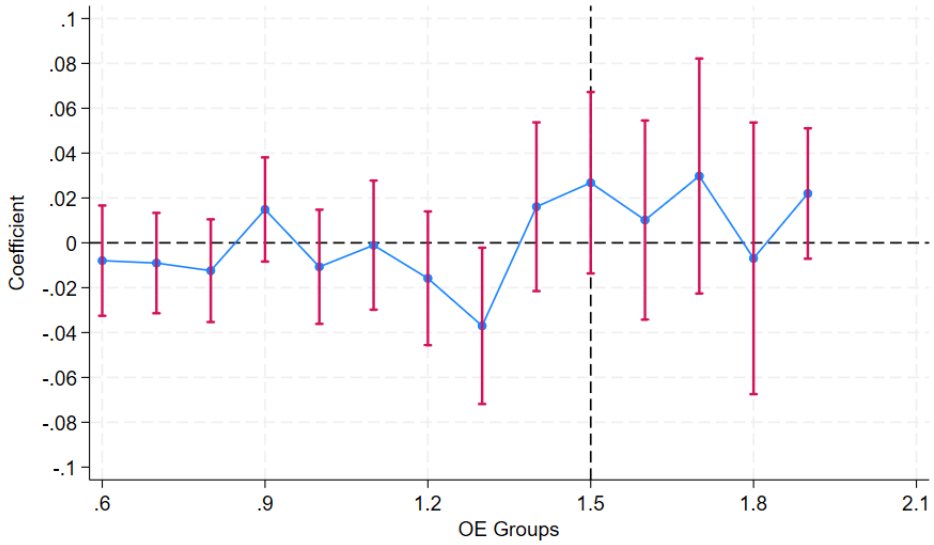
4.2 Patient Outcome

The richness of our data allows us to connect the changes in transplant center behavior to patient outcomes. We consider whether transplanted patients are more likely to die within

365 days after the transplant. We estimate equation 1 using only the set of transplanted patients as Section 4.1 but with Y_{ick} indicating whether patient i dies within 365 days after the transplant by center c with kidney k. We plot the full range of β_m in Figure 6.

Unlike the results in 4.1, we do not see a significant change in patient survival rates across the OE groups. There is no evidence to suggest that taking a kidney offer near or far from the threshold impacts patient survival.

Figure 6: Transplanted patient survival across different OE_{ck} groups



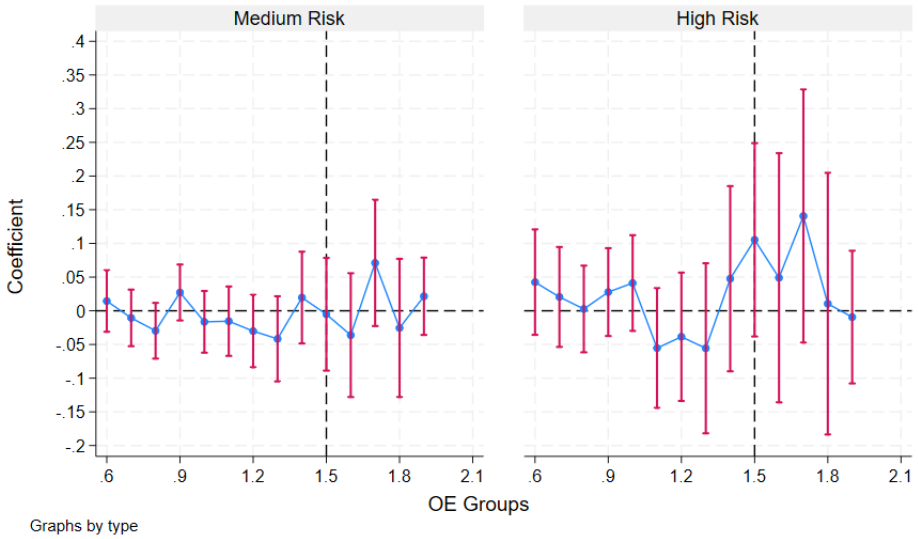
Note: The figure shows the survival rate for each OE group m after CoP. We plot the OLS estimates and 95% confidence intervals of the coefficients β_m from equation 1. We cluster standard errors at the center level.

Next, we examine if the effect of CoP on patient survival differs by risk profiles. We follow section 4.1.1 and categorize transplanted patient-kidney offers into low, medium, and high-risk. We use a similar specification to equation 3 to investigate if the effect of CoP on patient survival differs by risk profiles. We have Y_{ick} as an indicator for patient death within 365 days after the transplant for patient i with kidney k at center c. We estimate equation 3 for the subsample of transplanted patients and plot the coefficients of β_{mr} in Figure

There is no evidence in Figure 7 to suggest accepting a medium/high-risk transplant at the

threshold affects patient survival compared to a low-risk transplant

Figure 7: Transplanted patient survival between different risk groups



Note: The figure shows the transplanted patient's survival for each risk group r after CoP. We plot the OLS estimates and 95% confidence intervals of the coefficients β_m from equation 3. We cluster standard errors at the center level.

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Appendices

A CSR Report

Line		Center 1 Year	National 1 Year
	Adult (Age 18+)		
1	Transplants (n=number)	90	10,781
2	**Percent (%) of Patients Surviving at End of Period**		
3	Observed at this Center	87.78	86.26
4	Expected, based on national experience	89.41	
5	**Deaths During Follow-up Period**		
6	Observed at this center	11	1,392
7	Expected, based on national experience	8.48	1,392
8	Ratio: Observed to Expected (O/E)	1.30	1.00
9	(95% Confidence Interval)	(0.65-2.32)	
10	P-value (2-sided), observed v. expected	0.469	
11	How does this center's survival compare to what is expected for similar patients?	Not Significantly Different (a)	
12	Percent retransplanted	5.5	4.4
13	Follow-up days reported by center (%)	91.7	93.9
14	Maximum Days of Follow-up (n)	365	365

Figure 8: A page of a July 2005 CSR report.

Deceased Donor Graft Survival Model Description
1 Year (and 1 Month) after Transplant
Organ: Kidney
Adult (Age 18+)

93.6% graft functioning at 1 Year when all covariates=0. 97.7% graft functioning at 1 month when all covariates=0.
The indexes of concordance are 65.9%, 65.8%, and 66.2%, respectively.

	CSR Cohort Released 01/10/2006 Transplants between 07/01/2002 and 12/31/2004		
Characteristic Covariates	**beta**	**standard error**	**p-value**
Cold ischemia time: continuous (per 1 hour)	0.0106	0.0031	0.0007
Cold ischemia time: missing	0.4744	0.0844	<0.0001
Deceased donor kidney was pumped: missing (ref=no)	0.2558	0.3561	0.4725
Deceased donor kidney was pumped: yes (ref=no)	-0.0551	0.0621	0.3753
Deceased donor with history of diabetes: missing (ref=no)	0.3919	0.2804	0.1622
Deceased donor with history of diabetes: yes (ref=no)	0.2188	0.0868	0.0117
Deceased donor with history of hypertension: yes (ref=no)	0.1669	0.0597	0.0052
Diagnosis: Diabetes*	0.1122	0.0669	0.0932
Diagnosis: Hypertensive Nephrosclerosis*	-0.0305	0.0691	0.6589
Diagnosis: Polycystic Kidney Disease*	-0.3838	0.1064	0.0003
Diagnosis: Renovascular & Other Vascular Diseases*	-0.0354	0.1040	0.7338
Diagnosis: other or missing (includes tubular, congenital)*	-0.0380	0.0736	0.6057
Donation after cardiac death: yes (ref=no)	0.3368	0.0977	0.0006
Donor DSA different from recipient DSA: yes (ref=no)	0.1158	0.0621	0.0620
Donor age: 0-10 (ref=35-49)	0.3189	0.1262	0.0116
Donor age: 11-17 (ref=35-49)	0.0035	0.1028	0.9731
Donor age: 18-34 (ref=35-49)	-0.1131	0.0702	0.1070
Donor age: 50-64 (ref=35-49)	0.1757	0.0764	0.0215
Donor age: 65+ (ref=35-49)	0.3006	0.1250	0.0162
Donor meets expanded donor criteria for deceased donor kidney: yes (ref=no)	0.2174	0.0888	0.0143
Donor race: Hispanic/Latino	0.0406	0.0709	0.5666
Donor race: Asian	0.1553	0.1384	0.2620
Donor race: Black	0.0673	0.0674	0.3177
Donor race: multi-racial, other, unknown or missing	0.1637	0.2525	0.5168
Donor serum creatinine: continuous (per 1 mg/dL)	0.1040	0.0395	0.0086
Donor serum creatinine: missing	0.0112	0.3061	0.9708
Donor to recipient weight ratio: continuous	-0.1621	0.0765	0.0340
Donor to recipient weight ratio: missing	0.1952	0.1339	0.1450
Donor: deceased, COD cerebrovascular/stroke	0.2768	0.0547	<0.0001
Functional Status: performs activities of daily living with some or total assistance or is hospitalized (ref=no assistance)	0.3727	0.0624	<0.0001
Functional Status: unknown or missing (ref=no assistance)	0.0080	0.0844	0.9248

Figure 9: An example of how the risk adjustment model is presented in the CSR report.

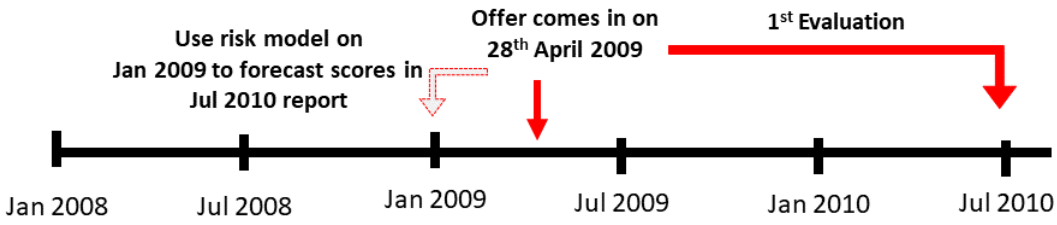

Figure 10: An illustration of how OE scores, $E[OE_{ck}]$ are constructed