Selection under risk adjustment: Evidence from U.S. deceased donor kidney transplant program*

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Abstract

Does rating improve a transplant center's quality of service? 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. Using a difference-in-difference framework and quasi-exogenous variation in the distance between a center's performance score and the CoP threshold, we do not find evidence that the post-transplant death rate improved. Instead, transplant centers closer to the cutoff are less likely to accept a kidney offer. Furthermore, smaller centers are more sensitive to the CoP policy than larger centers. These results suggest that transplant centers may optimize their performance scores by selecting against risky patients.

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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, it may create unintended consequences where hospitals optimize their performance scores by selecting against risky patients.

In this paper, we examine the effects of CoP on transplant center incentives in the context of the U.S. deceased donor kidney transplant program.

Literature Review: These papers study how to design the waitlist for kidney transplants. Agarwal et al. (2021); Agarwal, Hodgson and Somaini (2020); Zhang (2010); Bloch and Cantala (2017); de Mel et al. (2020); Arnosti and Shi (2020).

These papers look into the effect of CoP on transplant outcomes (Schold et al., 2014; Cameron and Sullivan, 2013; White et al., 2015; Schold, 2020) and (King et al., 2023; Wolfe et al., 2008; Ouayogodé, 2019; Matas and Schnitzler, 2004) provide a comprehensive review of the kidney transplant program.

These papers study how performance scores affect the incentives of healthcare providers (Dranove et al., 2003; Vatter, 2023)

2 Background and Institutional Settings

A patient diagnosed with end-stage renal disease (ESRD) has two options: dialysis or kidney transplant [1]. Costs are lower, and the quality of life is higher in the long run for patients who receive transplants, making this 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 process and details of Medicare's Conditions of Participation (CoP) program.

2.1 Registration at Transplant Centers

The physician refers patients to a local transplant center when they have kidney failure. The center's selection committee will evaluate if the patient is eligible for a kidney transplant (i.e., started dialysis or had a glomerular filtration rate (GFR) below 20mL per minute). The evaluation process may take up to months. The transplant center will then register accepted patients on the deceased donor waitlist and upload important information such as immunological profile, health conditions, and factors to compute priority into the UNet system(AKF, 2003).

2.2 Deceased Donor Kidney Allocation Process

The Organ Procurement and Transplantation Network (OPTN) designs and administers the deceased donor kidney allocation process. When brain death is declared 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

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

order [2](OPTN, 2023).

UNet simultaneously informs centers of all their patients compatible with the kidney to maintain organ viability [3]. Centers have 1 hour to indicate their decision. If several patients accept the kidney offer(s), the highest priority patient(s) will receive the transplant(s). 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).

2.3 Conditions of Participation (CoP)

Before July 2007, the OPTN was the primary organization responsible for monitoring transplant centers' performance [4] 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

[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]The primary performance metric is the number of patient survival post-transplant.

failures (E)[5]. 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 = $\Pr(\text{O-E} \geq 0) < 0.05$

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.[6].

[5]A failure is if the patient dies within 365 days after the transplant.

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

3 Data and Descriptive Analysis

In this section, we begin by describing the data sources. We then describe how we construct running OE scores for each patient-kidney offer. Finally, we present some descriptive statistics.

Potential Transplant Recipient (PTR): We draw information on the universe of patient kidney offers from the OPTN database from 2003 to 2012. This file contains all offers made to a patient on the waitlist. It documents when the kidney offer arrived, the final decision, reasons for rejection (if applicable), and the patient's ranking on the waitlist.

Standard Transplant Analysis and Research (STAR): Patient and deceased donor characteristics are available from the STAR file. We merge this data with the PTR data. It contains information on the patient's and deceased donor's demographics, health conditions, and immunological profile.

Center-specific report (CSR): SRTR publishes the CSR every six months, in June and December. Each CSR reports the transplant center's performance and activity within the six-month window[7]. CSR also contains the statistical model and variables Medicare uses to calculate a transplant's expected death rate. This information is crucial when constructing the transplant center's prevailing OE score for incoming patient-kidney offers. In the Appendix, we provide examples of CSR in Figure 6 and 7.

I merged the three datasets to conduct my analysis at the patient-kidney offer level.

3.1 Constructing running OE scores

CSR reports the transplant center's final OE score in June and December. However, we must know the prevailing OE score for every patient-kidney offer for our analysis. We

[7]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.

use the statistical model from the latest CSR report to construct the transplant center's prevailing OE score for each patient-kidney offer[8]. In Figure 8 of the Appendix, we provide an example of calculating the prevailing OE score for a patient-kidney offer.

3.2 Summary Statistics

Table 1 contains summary statistics on the patient sample. We can see that patient characteristics have changed over time. Since 2003, the average patient is now older (48.92 v.s. 52.47), more obese (26.97 v.s. 28.56), spend more years on the waitlist (2.29 v.s. 2.61) and more likely to have diabetes (37.09% v.s. 43.59%). In 2012, transplanted patients also fell by three percentage points.

Table 1: Summary Statistics of Patient Sample

	2003		2012	
	mean	sd	mean	sd
a)Patient Characteristics				
Age	48.92	13.61	52.47	13.75
Body Mass Index (B.M.I)	26.97	5.78	28.56	5.89
Time Spent on Waitlist	2.29	2.17	2.61	2.39
% Male	57.77	49.39	59.44	49.10
% White	45.40	49.79	40.80	49.15
% Diabetic	37.09	48.30	43.59	49.59
	.	.	.	.
b)Patient Outcome				
% Transplanted	12.02	32.52	8.93	28.52
% Died off waitlist	6.26	24.22	6.13	24.00
Observations	84461		135995	

Table 2 contains summary statistics on the transplant center sample. On average, transplant centers in 2012 admitted more patients and performed more transplants. The number of transplant centers is stable from 2003 to 2012, with 17 centers exiting and 19 entering. The average transplant center has similar numbers of neighboring centers in 2003 and 2012,

[8]This was motivated by conversations with surgeons who shared how their transplant center monitors performance after Medicare introduced Conditions of Participation.

suggesting centers have a stable competitive environment.

Table 2: Summary Statistics of Transplant Centers

	2003		2012	
	mean	sd	mean	sd
a) Center Activity				
Patients on waitlist	336.50	430.32	537.53	685.41
Transplanted patients	40.46	41.27	48.02	50.98
Admitted patients	108.19	125.18	149.80	166.49
Patients dying off waitlist	21.05	27.98	32.98	47.44
	.	.	.	.
b)Center Characteristics				
% Exit after 2003	6.77	25.18	.	.
% Joined since 2003	.	.	7.51	26.41
% Monopoly	2.39	15.31	3.16	17.53
% Duopoly	11.95	32.50	11.07	31.43
Nearby Centers	6.46	3.63	6.98	4.32
Observations	251		253	

4 Main Results

4.1 Changes in Acceptance rates after CoP

I estimate the effect of CoP on the transplant center's acceptance decision using a difference-in-differences analysis with the following equation:

$$\begin{aligned} Accept_{ik} = \alpha_0 &+ \sum_{m=0.5}^{1.8} \alpha_m \times \mathbb{1}\{E[OE_{ck}] \in m\} \\ &+ \sum_{m=0.6}^{1.8} \beta_m \times CoP_k \times \mathbb{1}\{E[OE_{ck}] \in m\} \\ &+ [\text{center FE}] + [\text{6-month window FE}] + \gamma_1 X_i + \gamma_2 X_k + \varepsilon_{ik} \end{aligned} \tag{1}$$

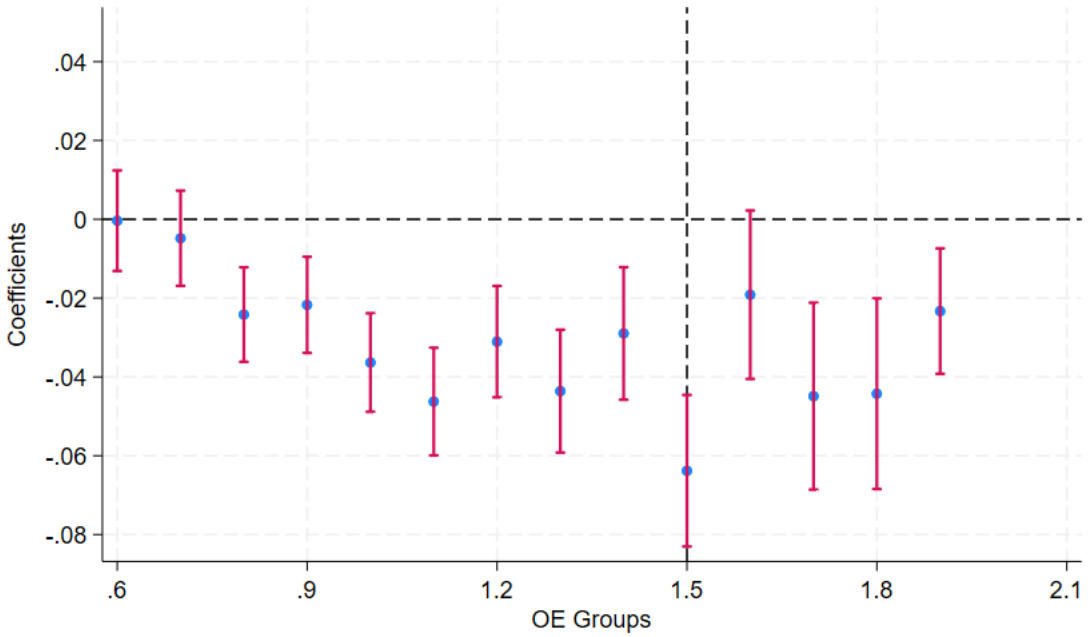
where $Accept_{ik}$, equals 1 if individual i with kidney k was accepted by the transplant center. CoP_k equals 1 if kidney k arrives after CoP was implemented. $\mathbb{1}\{E[OE_{ck}] \in m\}$ is equals 1 if $E[OE_{ck}]$, the prevailing OE score is in the mth bin. Fixed effects for an individual's transplant center capture baseline center differences in acceptance rates, while 6-month window fixed effects capture how acceptance evolves for the sample as a whole. The vectors X_i and X_k are various patient and kidney characteristics.

The main parameter in equation 1 is β_m, the coefficients on the interactions of CoP and OE group indicators. The term β_m nonparametrically captures how the change in OE group m's acceptance rate between the pre and post-policy differs from the change in the control group's acceptance rate over the same period. Specifically, β_m identifies the causal effect of CoP on the various OE group's acceptance rates under the assumption that the acceptance rate among the treatment groups would have paralleled the control groups in the absence of CoP.

Estimates of β_m are presented in Figure 1 for each OE group according to their distance to the threshold of 1.5. As we approach the cutoff, the acceptance rate decreases and drops by

six percentage points at the cutoff, equivalent to an 18.2% drop in acceptance rate at the cutoff relative to the control group (i.e., $\mathbb{1}\{E[OE_{ck}] < 0.5\}$). The acceptance rate continues to drop even as we cross the cutoff but at a lower percentage point. All these suggest that transplant centers are forward-looking and consider their OE scores when deciding to accept the kidney offer for the patient.

Figure 1: Acceptance rates for the different $E[OE_{ck}]$ groups



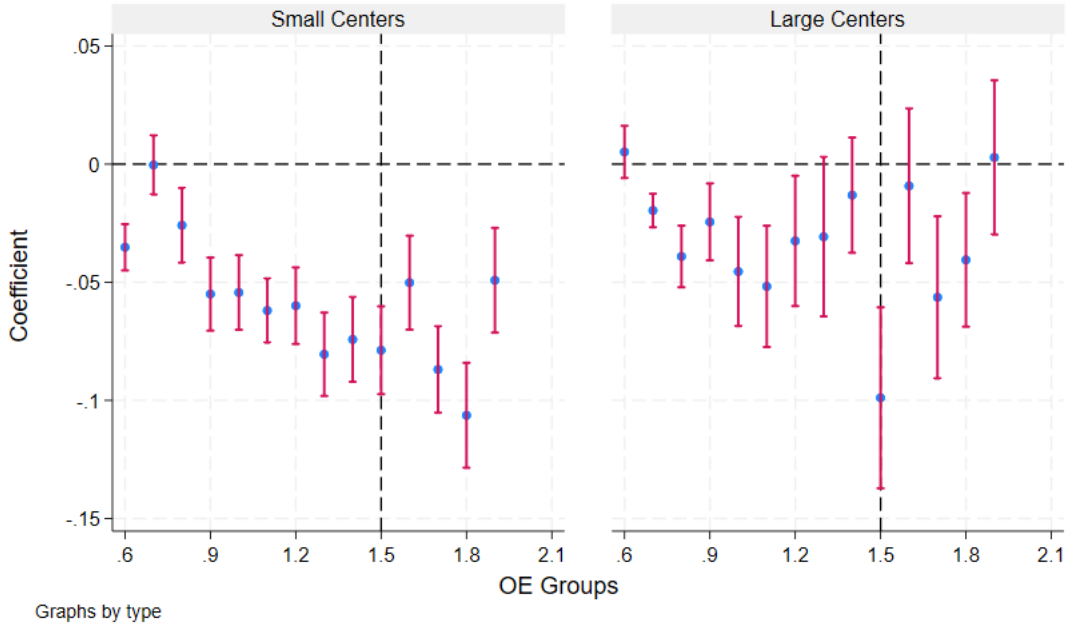
Note: The figure shows how the acceptance rate of kidney offers evolved for each OE group after CoP. We plot the OLS estimates and 95% confidence intervals of the coefficients β_m from equation 1. We cluster standard errors at the transplant center level.

4.2 Changes in Acceptance Rate for different transplant centers

Finally, I examine whether the effect of CoP on acceptance rate varies by transplant center size. I categorize all transplant centers into small and large centers and estimate equation 1.

The acceptance rates for all center sizes decrease as OE scores approach 1.5. This decrease is more considerable and consistent for the small centers. We only see a substantial drop in acceptance rates for large centers at the cutoff. The results in Figure 2 suggest small centers

Figure 2: Acceptance rates for the different center size



Note: The figure shows how the acceptance rate of kidney offers evolved for different centers 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 transplant center level.

have a lower tolerance for failure than large centers. Selective treatment kicks in earlier for small centers than large centers.

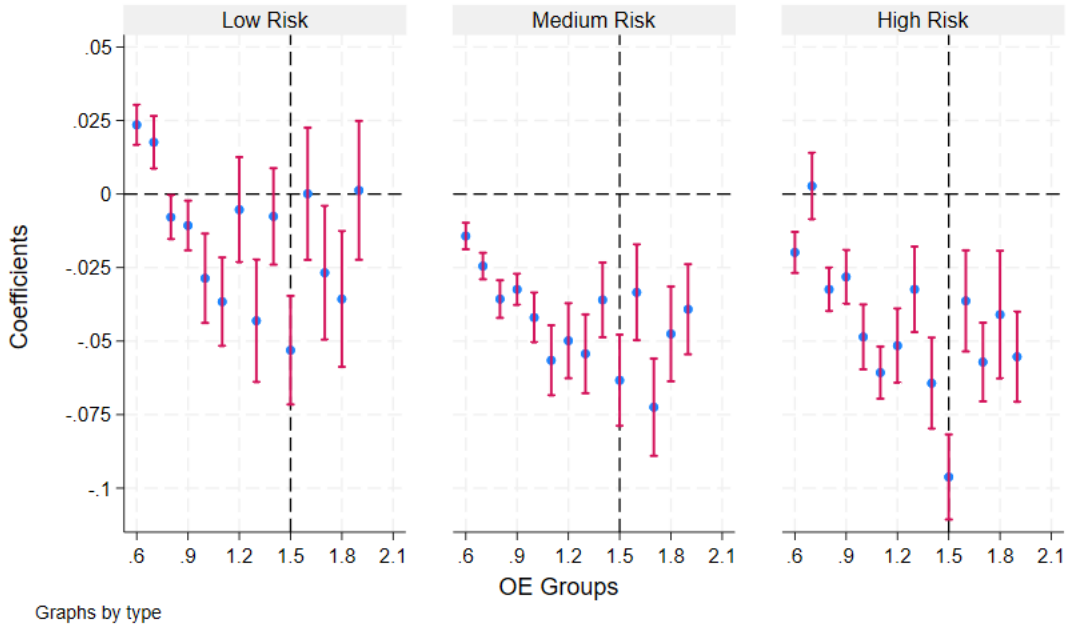
This result has important policy implications. The current CoP policy implements a uniform cutoff for all transplant centers. However, the results in Figure 2 suggest that small centers are more sensitive to the CoP policy than large centers, putting the patients in a small center at a disadvantage.

4.3 Changes in Acceptance Rate for different risk profile

Next, we examine whether the effect of CoP on acceptance rate varies by transplant risk profile. We categorize all patient-kidney offers into three risk groups: low, medium, high,

and estimate equation 1[9]. Estimates of β_m are presented in Figure 3 for each risk group.

Figure 3: Acceptance rates for the different risk groups



Note: The figure shows how the acceptance rate of kidney offers evolved for different risk groups 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 transplant center level.

The acceptance rate for all risk groups decreases as OE scores approach 1.5. However, the drop is most significant for the high-risk group. The acceptance rate for the high-risk group drops by ten percentage points at the cutoff, equivalent to a 30.3% drop in acceptance rate relative to the control group. The acceptance continues to fall even as we cross the cutoff but at a lower percentage point. This effect is the smallest for low-risk transplants. The results in figure 3 suggest that transplant centers are more likely to reject medium/high-risk transplants as their OE scores approach 1.5.

[9]I provide details of how I define the different risk groups in the Appendix.

4.4 Quality of service after CoP

Studies of performance rating have found a positive correlation between performance rating and quality of service (Vatter, 2023; Dranove et al., 2003)[10]. We examine whether the CoP policy improved a transplant center's quality of service. We use the post-transplant death rate as a proxy for quality of service. I estimate the effect of CoP on the transplant center's death rate using a difference-in-differences analysis with the following equation:

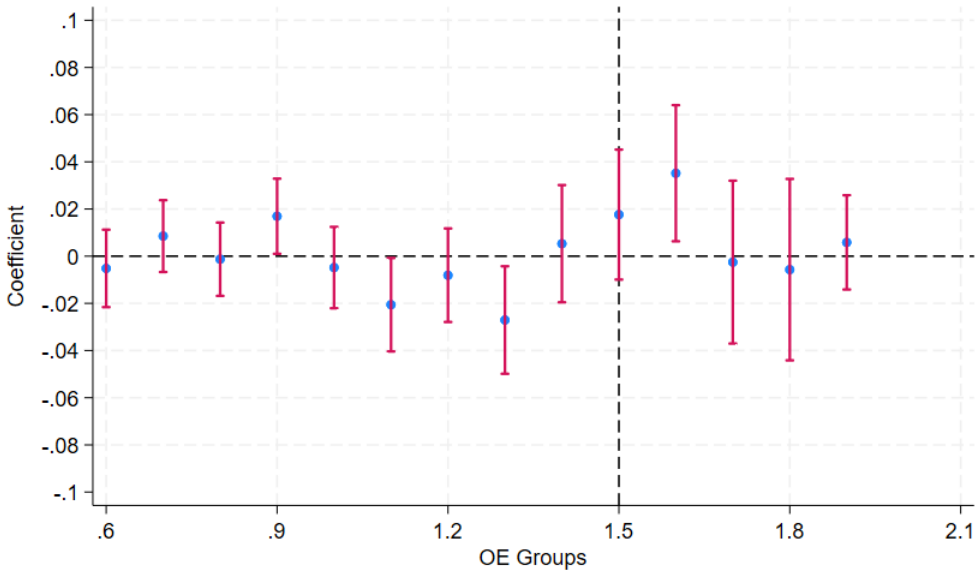
$$\begin{aligned} Death_{ik} = \alpha_0 &+ \sum_{m=0.5}^{1.8} \alpha_m \times \mathbb{1}\{E[OE_{ck}] \in m\} \\ &+ \sum_{m=0.6}^{1.8} \beta_m \times CoP_k \times \mathbb{1}\{E[OE_{ck}] \in m\} \\ &+ [\text{center FE}] + [\text{6-month window FE}] + \gamma_1 X_i + \gamma_2 X_k + \varepsilon_{ik} \end{aligned} \tag{2}$$

where $Death_{ik}$, equals 1 if individual i with kidney k died within 365 days after the transplant. Estimates of β_m are presented in Figure 4

From Figure 4, estimates of β_m are mostly statistically insignificant. There is insufficient evidence to suggest that CoP improved the center's quality of service. I also examine whether CoP's mortality effect differs across risk groups. I estimate equation 2 for different risk groups, and found no significant effects in Figure 5

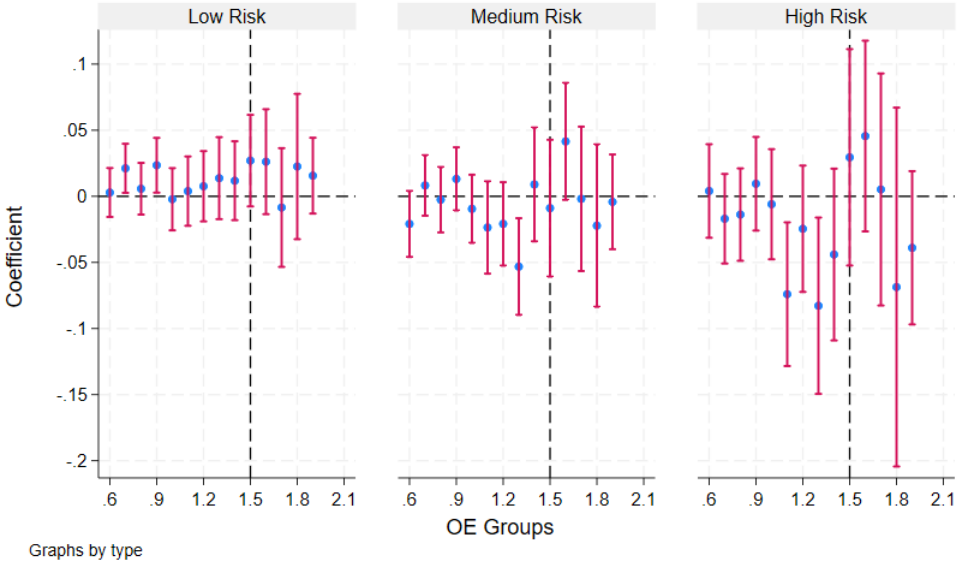
[10]In the Appendix Figure 9, post-transplant 1-year death rate has dropped by five percentage points from 2003 to 2012.

Figure 4: Death rates for the different $E[OE_{ck}]$ groups



Note: The figure shows how the death rate of accepted offers evolved for each OE group after CoP. We plot the OLS estimates and 95% confidence intervals of the coefficients β_m from equation 2. We cluster standard errors at the transplant center level.

Figure 5: Death rates for the different risk groups



Note: The figure shows how the death rate of accepted offers evolved for different risk groups after CoP. We plot the OLS estimates and 95% confidence intervals of the coefficients β_m from equation 2. We cluster standard errors at the transplant center level.

5 Conclusion

JMP success

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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 6: 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 7: An example of how the risk adjustment model is presented in the CSR report.

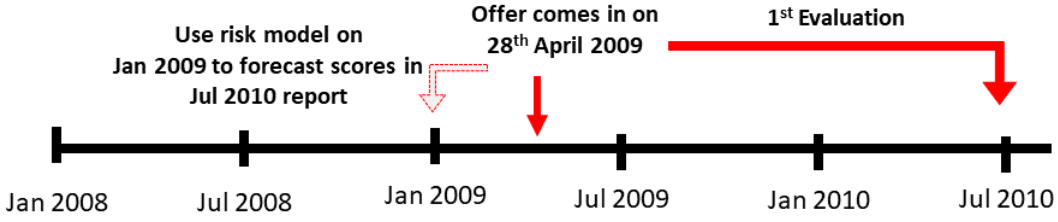

Figure 8: An illustration of how OE scores, $E[OE_{ck}]$ are constructed

Figure 9: Post-transplant death rate is decreasing over 2003 - 2012.