Incentives and Performance in the U.S. Organ Donation System*

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Abstract

We study how performance-based regulation affects monopolistic providers in U.S. organ procurement. A 2019 reform introduced standardized metrics and decertification risk for Organ Procurement Organizations (OPOs). We show the policy weakened scope economies across organs, inducing specialization. Using difference-in-differences, we find that kidney procurement rose by 7.13 organs per OPO monthly (29% increase), driven by high-performing OPOs. Despite increased procurement costs, reduced dialysis spending generates estimated fiscal savings of $577 million annually. The results show how accountability policies can improve output in regulated monopolies while reshaping production structure and cost efficiency.

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1 Introduction

Organ transplantation significantly improves quality of life and survival for patients with severe organ failure, representing a vital advancement in modern medicine (Meier-Kriesche and Schold, 2005; Tonelli et al., 2011).[1] The United States, performing over 45,000 transplants annually, operates the world's largest transplantation market. This system currently relies on 56 Organ Procurement Organizations (OPOs), regulated by the Centers for Medicare and Medicaid Services (CMS).[2] OPOs hold monopolistic rights within designated service areas to recover deceased donor organs, supplying 287 transplant centers and managing a national waitlist of over 100,000 individuals, which grows by approximately 150 patients daily (DeRoos et al., 2021; Spardy et al., 2023).[3] While intended to streamline operations, this monopolistic framework has faced criticism for inefficiencies, performance variability, and limited transparency and accountability (Goldberg et al., 2017), as well as for creating perverse incentives that inefficiently reduce both organ recovery and successful transplantations (Chan and Roth, 2024). These concerns reflect a deeper regulatory challenge: oversight in this system depends on how performance is measured and used to discipline organizations that operate as local monopolies.

In this paper, we study how performance measurement and competitive pressure shape behavior in a regulated multi-output industry. We examine the 2019 CMS reform of the U.S. organ procurement system, which introduced a performance-based decertification threat that altered the incentives of the local monopoly OPOs. The reform replaced self-reported metrics with standardized, independently verified measures—specifically, donation and transplantation rates (Goldberg et al., 2019; Lentine and Mannon, 2020)—and tied organizational survival to relative performance through a new Tier Ranking System. These changes raised the returns to measured outputs and provide a unique opportunity to analyze how changes in performance metrics and reward structures affect production choices, costs, and market structure when organizations jointly produce multiple outputs.

Given the redesign of performance measurement and sanctions, economic theory yields compet-

[1] For instance, kidney transplantation has been shown to increase survival rates for patients with chronic kidney disease compared to long-term dialysis, while liver and heart transplants are often life-saving interventions for patients with acute or progressive organ failure (Tonelli et al., 2011; Meier-Kriesche and Schold, 2005).

[2] Prior to December 31, 2020, there were 58 OPOs. On January 1, 2021, two OPOs merged, reducing the total to 57. A second merger, also involving two OPOs, occurred in 2023, bringing the total down to 56.

[3] See the Health and Human Services Administration's website for the *National Transplant Waiting List Statistics*.

ing predictions about the reform's effects. Stronger incentives can increase effort and efficiency, but they can also shift activity toward easily measured dimensions, weaken scope economies, and encourage specialization and consolidation. Consistent with these tensions, the reform indeed increased measured performance and costs, while generating unintended consequences such as greater waste (recoveries without transplantation) and changes in the internal organization of production. Whether such policies ultimately enhance welfare therefore depends on the interaction between measurement design, organizational technology, and endogenous responses. Prompted by public scrutiny and legislative action, the policy sought to improve accountability and transparency among OPOs, though concerns remain that it could increase market concentration and reduce competition.[4]

A key institutional feature of the U.S. procurement system is asymmetric reimbursement across outputs. For kidneys, CMS provides full reimbursement of reported procurement costs, whereas reimbursement for other organs is negotiated between OPOs and transplant centers.[5] This structure generates differential marginal returns within organizations that jointly produce kidneys and other organs, creating incentives to reallocate effort across outputs. If the 2019 reform strengthened the salience of kidney-centered metrics, these incentives should manifest as (i) a divergence in kidney versus non-kidney quantities and costs, and (ii) changes in the cost interaction between outputs, shifting organizations toward specialization or diversification depending on the sign of scope economies (Baumol et al., 1982). We exploit this prediction by linking organ-level quantities to OPO financial reports to trace how the reform affected both production choices and the underlying cost structure.

Figure 1 displays patterns consistent with these predictions. Prior to 2019, costs (panel (a)) and quantities (panel (b)) for kidneys and other organs evolved along broadly parallel paths, suggesting stable cost complementarities. After the reform, kidney costs accelerated sharply—more than doubling between 2019 and 2024—while costs for other organs grew much more gradually. A similar divergence appears in quantities: total recoveries increased from 37,858 in 2018 to 54,056 in 2023 (annualized above 57,600 in 2024), with kidneys accounting for most of the expansion. These

[4] Detailed information on the full rule and its history can be accessed in the Federal Register at CMS's final rule (42 CFR §486).

[5] Rosenberg et al. (2020) argue that the reimbursement structure may generate perverse incentives affecting resource allocation within OPOs. The asymmetry is reinforced by institutional features: kidney allocation operates under a national UNOS framework and Medicare covers transplantation for ESRD patients, making kidneys the dominant organ in the system (30,000 annually) (Sönmez and Ünver, 2023; Agarwal et al., 2025). Not surprisingly, kidney exchange was an early application of market design (Roth et al., 2004, 2007).

organ-specific breaks, aligned with the timing of the reform and the reimbursement asymmetry, motivate a difference-in-differences design that treats kidneys as the most exposed output while controlling for pre-existing trends and regional procurement practices.[6]

Our empirical analysis combines multiple sources of information spanning more than a decade. In particular, using unique data primarily derived from standardized cost reports obtained through a Freedom of Information Act (FOIA) request, we gather information on industry-wide costs and operations between 2015 and 2024.[7] We also compile official monthly records on OPO-level procurement and transplant activities from 2011 to 2024.

This study contributes to two strands of the literature. First, it documents how objective metrics reallocate effort within mission-driven monopolies. Specifically, we provide the first comprehensive empirical analysis of the CMS final rule's effects across all major organ types. We document positive trends in organ recovery and hospital interactions with OPOs from 2011 to 2024, with a notable acceleration following the reform. Importantly, growth primarily occurred within lower-performing OPO tiers, initially driven by kidneys. Improvements largely came from strengthening existing hospital relationships rather than establishing new partnerships. Then, using a difference-in-difference framework, we estimate that the policy led to an average monthly increase of 7.129 kidneys per OPO per month compared to a baseline mean in the control group of 24.3 organs per OPO per month. This increase was accompanied by significant positive effects on costs, especially for the lowest-ranked OPOs. Based on our estimates, we also provide an illustrative estimate of the broader financial impact of increased kidney recovery by approximating its effect on healthcare spending. The estimated patterns are consistent with multi-task agency models in which narrowly defined performance measures distort input allocation across outputs, rather than with explanations based on capacity shocks or general improvements in donor supply.[8]

Second, to our knowledge it provides the first causal evidence that regulatory incentives can reshape the scope of production in multi-output organizations. Prior work has estimated economies of

[6]While COVID-19 disrupted transplant activity in 2020–2021 (Boyarsky et al., 2020), the kidney-specific and persistent post-reform increase – absent for other organs – points to incentive effects rather than pandemic capacity constraints.

[7]For detailed information about the cost report, see next sections and Form CMS 216-94.

[8]Bae et al. (2025) provides descriptive evidence on how organ procurement organizations (OPOs) responded to the CMS new performance evaluation regime. Using national death data linked to transplant records from 2019–2023, they show that after the public release of the 2021 tiered performance report, lower-performing OPOs substantially increased organ recovery and partially closed the gap with higher-tier OPOs, particularly for kidneys. We complement thus evidence by providing a causal evaluation that links quantities to costs and internal organization.

scope in health care primarily through consolidations or cross-sectional comparisons (Dranove, 1998; Preyra and Pink, 2006). We instead exploit the tiered incentives created by the CMS reform to identify within-OPO changes in cost complementarities. Our findings indicate that the reform weakened cost complementarities between kidneys and other organs, inducing specialization rather than diversification. These effects are strongest among Tier 2 OPOs, which faced the largest shift in performance pressure, and are absent for Tier 3 organizations. These results suggest that the CMS reform altered how existing kidney-focused financial incentives shaped organizational structure, not merely output levels.

Ultimately, this research examines how performance metrics and financial incentives interact to shape organ procurement practices, addressing the critical need for efficient and equitable organ distribution systems. However, questions remain regarding the effectiveness of the reform. Critically, the reform's focus on performance metrics may fail to address deeper structural issues such as cost-shifting and market consolidation.[9] Additionally, increasing donor registrations, adopting innovative medical technologies, and refining allocation algorithms remain essential for improving system performance (Ozgur et al., 2023).

The paper is organized as follows. Section 2 provides an overview of the institutional background governing organ donation in the United States and discusses the 2019 reform. Section 3 describes our data sources, presents key trends, and offers initial exploratory analysis. In Section 4, we introduce our empirical model and identification strategy and report the main results for organ-related outcomes. Section 5 presents our findings on costs, while Section 6 examines heterogeneous impacts across OPO tiers. Section 7 concludes.

2 Background

The National Organ Transplant Act (NOTA) of 1984 established the framework for the U.S. organ donation and transplantation system, including the regulation of OPOs. Today, 56 OPOs operate nationwide, playing a critical role in coordinating organ donation and transplantation. Each OPO is responsible for identifying potential organ donors, obtaining family consent, coordinating surgical organ recovery, and ensuring the timely transportation of organs to transplant centers. Further-

[9] Recent anecdotal evidence suggests that OPOs may be incentivized to bypass the national organ waiting list to meet reform targets (Rosenthal et al., 2025).

more, NOTA grants OPOs monopoly rights within their designated service areas (DSAs). Figure 2 illustrates the geographic extent of these areas and their spatial distribution across the United States as of 2024. However, despite this geographical exclusivity, OPOs do not manage organ allocation. Instead, this responsibility falls to the Organ Procurement and Transplantation Network (OPTN) and the United Network for Organ Sharing (UNOS), while final acceptance decisions rest with individual transplant centers. These additional players add an important layer of oversight, ensuring equitable and ethical distribution of organs (Council et al., 2022).

However, unlike conventional economic markets, where supply and demand determine prices, the organ donation market operates under an altruistic model, relying on voluntary donations and the consent of the donor's next of kin. Organ recovery has historically been managed by hospitals locally, without any federal oversight or ethical guidelines. The growing demand for transplants, advancements in recovery technology, and variation in organ allocation have prompted government intervention, leading to the enactment of NOTA. Today, this market is regulated under NOTA by the Health Resources and Services Administration (HRSA) within the Department of Health and Human Services (HHS). NOTA prohibits direct financial transactions for organs to prevent exploitation and ensure equitable access to transplantation (Roth, 2007; Satz, 2010; Sönmez and Ünver, 2023).

The reliance on voluntary participation results in persistent organ shortages, leading to long waiting lists and ongoing policy discussions on optimizing donor rates while maintaining ethical standards (Becker and Elias, 2007; Held et al., 2021). Although more than 45,000 organ transplants are performed annually in the U.S., the market still faces a backlog of over 100,000 individuals on the national transplant waiting list, with approximately 7,500 people dying each year due to organ shortages (DeRoos et al., 2021; Spardy et al., 2023). Consequently, OPOs operate under immense pressure to balance the limited supply of donor organs with the high demand for transplants (Dickert-Conlin et al., 2019). Given the time-sensitive nature of organ viability, these organizations must operate with precision to maximize successful transplant outcomes.

An important critical challenge for the industry is the financial structure and incentives of OPOs, which can significantly shape the organ recovery market. For instance, under CMS's reimbursement model for kidneys—reflecting the substantial public cost burden associated with End-Stage Renal Disease (ESRD)—OPOs receive full reimbursement for all incurred costs related to kidney procurement, irrespective of whether these organs are ultimately transplanted (Bragg-Gresham et al., 2024). In contrast, other solid organs such as livers, hearts, and lungs are reimbursed predominantly through private insurance entities via real-time negotiated pricing with transplant centers, creating an additional layer of administrative and financial complexity. This difference in reimbursement policies initially designed to eliminate financial disincentives for kidney recovery, may inadvertently incentivize OPOs to prioritize kidneys over other organs, given the lower administrative burden and assured financial coverage. This skewed incentive structure could undermine efforts to maximize the recovery of all transplantable organs, particularly those with shorter viability windows that require swift and complex negotiations (Tonelli et al., 2011; Held et al., 2021). Ultimately, these operational and fiscal conditions raise broader concerns about whether existing financial incentives adequately align with the overarching goal of optimizing organ availability and equity in transplantation (Cheng et al., 2021, 2022).

In recent years, OPOs have faced increased scrutiny over performance disparities and operational inefficiencies. Investigations by the House Oversight Committee, the Senate Finance Committee, and the Office of Inspector General at the Department of Health and Human Services have highlighted concerns regarding variations in OPO performance, accountability, and financial transparency. [10,11,12,13] In response, performance standards for OPOs have been developed by CMS and HRSA. These metrics focus on donor identification, family consent rates, efficient recovery processes, and quality assurance programs (Held et al., 2021). Recent regulatory reforms aim to standardize efficiency, reduce disparities, and identify underperforming OPOs for corrective action (Mathur, 2022).

Despite periodic reviews by CMS, the different regulatory mechanisms and the U.S. operating the largest organ transplant program globally, a critical gap remains in evaluating the performance of the organ procurement market with most notably a lack of rigorous empirical analyses on the efficiency, cost-effectiveness, and quality of organ procurement across different organ types. Research on the cost and quality of procured solid organs—such as kidneys, livers, hearts, lungs, and pan-

[10] Chairman's News — Newsroom — The United States Senate Committee on Finance.

[11] The United States Senate Committee on Finance requests clarification regarding "Medicare Paid Independent Organ Procurement Organizations Over Half a Million Dollars for Professional and Public Education Overhead Costs That Did Not Meet Medicare Requirement.

[12] Medicare Paid Independent Organ Procurement Organizations Over Half a Million Dollars for Professional and Public Education Overhead Costs That Did Not Meet Medicare Requirements, A-09-21-03020.

[13] Oversight Subcommittee Launches Investigation into Poor Performance, Waste, and Mismanagement in Organ Transplant Industry — House Committee on Oversight and Reform.

creases—is limited. Most studies focus on kidney procurement, leaving other organs, which make up about 50% of the transplant market, under-researched (Held et al., 2020, 2021; Bragg-Gresham et al., 2024). In addition, the market structure of OPOs, which operate as regional monopolies, raises concerns about inefficiencies and financial mismanagement, with U.S. Senate hearings and investigative reports highlighting issues with oversight and transparency in OPO practices.

2.1 The 2019 reform

In late 2018, media stories[14] and legislative attention—most notably from Senator Todd Young's announcement of a bill proposal for OPO reform[15]—highlighted perceived deficiencies in OPO performance. These developments led to a major federal policy initiative during the first Trump Administration, which issued the Advancing American Kidney Health Executive Order (Executive Order 13879) on July 10, 2019. The Executive Order directed the CMS to revise OPO performance regulations and metrics, signaling a major shift in how OPOs would be evaluated and held accountable.

In December 2019, CMS published a proposed rule under 42 CFR §486 (CMS, 2019)[16], introducing new standards that OPOs must meet for recertification. After a period of public comment and debate, the Final Rule was announced on November 20, 2020, with implementation beginning on August 1, 2022. These revised regulations mark a departure from the previous system of self-reported data and introduce a 4-year transition period, culminating in an initial CMS review in 2026 that may result in the de-certification of underperforming OPOs.[17] Thus, for the first time, OPO contracts are subject to competitive pressure based on transparent and standardized performance metrics rather than predominantly self-reported data and face potential de-certification.

Central to these reforms is the Tier Ranking System, which classifies OPOs into three performance tiers according to two primary outcome measures: (1) donation rate and (2) organ transplantation rate. The donation rate measures the number of actual deceased donors as a percentage of total

[14] For example see Organ transplant shortage could be fixed by expanding donor pool - Washington Post and Despite low performance, organ collection group gets new federal contract - The Washington Post published in *The Washington Post*.

[15] https://www.young.senate.gov/newsroom/press-releases/washington-post-young-demands-reform-of-organ-transplant-network/

[16] https://www.federalregister.gov/d/2020-26329

[17] Note that OPOs receive their ranking with a two-year lag. This time lag exists because CMS relies on publicly available data from sources such as the CDC and SRTR, which are not immediately available.

inpatient deaths within the OPO's DSA, whereas the organ transplantation rate measures the number of transplanted organs (rather than simply recovered organs) as a percentage of those same inpatient deaths. These metrics evaluate OPO effectiveness in both procuring organs from potential donors and ensuring those organs are transplanted successfully (Goldberg et al., 2017, 2019). Notably, the new rule bases these measures on independently verified data from the Centers for Disease Control and Prevention (CDC) rather than relying on OPO-reported "eligible deaths", to address the historical lack of transparency and consistency in defining the donor-eligible pool.

Under this system, Tier 1 includes OPOs that rank in the top 25% for both donation and transplantation rates, and these OPOs are automatically re-certified for an additional 4 years and retain exclusive rights to their DSA. Tier 2 includes mid-performing OPOs that meet the median threshold for both donation and transplantation rates but do not reach the top quartile, and these organizations compete for their DSAs if they cannot demonstrate improved performance. Finally, Tier 3 OPOs, whose donation or transplantation rates fall below the median threshold, face de-certification and an immediate opening of their DSAs for competition. In line with the 4-year transition window, the initial data for recertification will rely on OPO performance from 2023 and 2024, with CMS ranking OPOs and conducting on-site surveys in early 2026. This timing ensures that OPOs have a defined period to implement performance-enhancing strategies before the first review under the new system.[18]

The Tier Ranking System introduces several policy changes to enhance OPO accountability and outcomes by replacing self-reported data with standardized, independently verified measures. First, the denominator for new performance metrics is based on inpatient death data from the CDC, ensuring consistency across OPOs and preventing manipulation of eligible death counts. Second, the donation rate measure now considers actual organ donors with at least one transplanted organ rather than focusing on donor yield, which previously discouraged the procurement of single-organ donors. Third, the organ transplantation rate prioritizes successful organ placement rather than just procurement, reducing waste and improving transplant outcomes. Finally, by relying on independently verified data and tracking actual transplants rather than organ recoveries, the system enhances transparency and accountability, ensuring a more accurate and trustworthy evaluation of OPO performance.

[18]OPOs are assigned to a specific tier based on how they perform on both measures relative to their peers. For example, to be in Tier 1, an OPO must be in the top 25% for both donation rate and organ transplantation rate. For Tier 2, OPOs must meet at least the median threshold for both metrics.

The Tier system changes the way OPOs are evaluated by introducing a new performance-based categorization that aims to foster improvement and hold underperformers accountable. The three-tier approach creates incentives for OPOs to improve their performance, as organizations in higher tiers are rewarded with recertification and retention of their DSAs, while those in lower tiers risk decertification or competition for their DSAs. This system is intended to ensure that DSAs are served by OPOs capable of maximizing organ procurement and transplantation opportunities, ultimately striving to improve organ donation and transplantation rates.

Despite these efforts, initial analyses suggest that these new standards could have substantial ramifications. Studies modeling how OPOs would have performed under similar metrics in 2016–2017 show that over half of all OPOs might fail one or both new thresholds, potentially facing decertification (Snyder et al., 2020). Moreover, this approach also raises several concerns about the long-term impact of the Tier Ranking System. One risk is market concentration if high-performing OPOs acquire multiple DSAs. By opening the DSAs of mid- and low-performing OPOs to competition, high performers may consolidate control over larger regions. Such consolidation could diminish the incentive for OPOs to improve services and innovate, as fewer organizations control larger regions without the pressure of competitors. Furthermore, while the system encourages performance improvement, it does not provide a clear mechanism for introducing new competition within DSAs, as existing OPOs tend to have a stronghold in their regions.

Critical to this paper, the CMS metrics do not assign explicit weight to any specific organ, nor does the reform address the fundamental differences among organs or the financial incentives that influence OPO behavior. For instance, kidneys significantly impact performance metrics due to their high demand—they account for approximately 50% of all transplants and each donor can provide two. As a result, OPOs that effectively recover and place kidneys tend to achieve higher transplant rates. Although CMS employs a dual-metric system to balance donation and transplant rates, kidney transplants still disproportionately influence outcomes. Consequently, OPOs cannot attain high performance scores without recovering and placing kidneys at rates comparable to top-performing peers.

Organ viability also shapes OPO behavior. Kidneys are the most resilient, remaining viable for 24–36 hours, which allows time to identify recipients across greater distances. In contrast, hearts and lungs must be transplanted within 4–6 hours, and livers and pancreases within 8–18 hours.

This means kidneys can be widely offered and accepted even after initial declines, whereas hearts and lungs must be placed quickly or risk being discarded—negatively affecting performance metrics.

Moreover, financial incentives play a critical role. Medicare guarantees full reimbursement for kidney procurement, even when efforts do not result in successful transplantation. This policy incentivizes OPOs to prioritize kidney recovery over other organs. The result is a potential imbalance: increased kidney donation rates alongside stagnant recovery of organs such as livers, hearts, lungs, and pancreases. OPOs may concentrate resources on kidneys, where costs are reliably covered, while underinvesting in the technologies and processes needed to improve non-kidney organ procurement. Therefore, although the CMS reform may enhance kidney transplantation rates, it may fall short in advancing the broader goals of the organ donation system and meeting the diverse needs of transplant patients.

3 Data and exploratory analysis

Our analysis draws on multiple data sources, at varying frequencies, that provide rich financial information for the vast majority of OPOs and detailed longitudinal records on organ-related activities for the universe of OPOs operating nationwide over the past decade.

Our first source of information provides detailed data on various cost items for the 51 private, non-hospital-based OPOs, covering the period from 2015 to 2024.[19] As mandated by CMS regulations, each OPO must submit a standardized cost-reporting form (CMS 216-94), ensuring consistency in cost and operational comparisons. Through a FOIA request, we obtained over 12,000 pages of financial and operational data from these forms for the years 2015 to 2021. Using the Health Financial Services (HFS) software, we converted the FOIA-provided reports into machine-readable format by manually entering each figure from the reports into the software. We then verified our entries by comparing page-level sums with the FOIA source. As a quality assurance measure, a second individual randomly reviewed pages from each report. For the years 2022 and 2024, we used newly released data from CMS, which provides HFS software output of OPOs' standardized

[19] At the time of the reform, 58 OPOs were operating nationwide. Financial data are available only for the 51 independent, private OPOs that file separate cost reports with CMS. The remaining OPOs are hospital-based and do not submit standalone OPO cost reports. Instead, their financials are integrated into the hospital-level reports of their affiliated transplant centers, making OPO-specific financial data unavailable.

cost-reporting forms starting with 2020.[20] We then mapped the HFS software output onto the FOIA data structure. Since we had data for 2020 and 2021 from both sources, so we were able to manually compare them to find a perfect match.

Form CMS 216-94 provides detailed data in Worksheet B on the total cost for each organ, covering organ-specific expenses, overhead expenses, and administrative and general expenses.[21] The form also includes data on the number of full-time employees and top management compensation in Worksheet S-1. We supplemented each OPO's financial and operational data with geographic information from the Scientific Registry of Transplant Recipients regarding population and coverage areas; hospital, donation center, and donor-specific data from the OPTN; wage index data from the CMS; and CEO salary data from IRS Form 990, in addition to the salary data obtained through FOIA. The final sample includes a total of 455 OPO-year observations.

To obtain more granular insights into OPOs' organ procurement and transplant activities, we employed monthly data from the OPTN, administered by the United Network for Organ Sharing (UNOS). This dataset covers the period from January 2013 through September 2024 and provides monthly organ procurement statistics for all 58 OPOs in the U.S., disaggregated by organ type and hospital of procurement for each OPO. We linked these data to Form CMS 216-94 by manually verifying OPO names and ZIP codes.

Finally, to examine the impact of the recent reforms in the organ procurement industry that were introduced in 2019, we classified the OPOs into the three Tiers based on CMS's final rule (42 CFR §486) that was published in December 2020 and used the OPOs' financial data from the 2018 fiscal year.[22] The OPO Tier ranking system, based on data from 2018, classifies OPOs into three categories: Tier 1 (passing OPOs), Tier 2 (under-performing OPOs), and Tier 3 (failing OPOs).

We first document trends in total standard acquisition costs over the period 2013–2024. Table 1

[20]The information can be accessed through the CMS website: Healthcare Cost Report Information System Dataset - Organ Procurement Organization.

[21]The total cost for each organ is constructed as follows. First, we begin with organ-specific costs from Worksheet A-2 (Organ Acquisition Cost), which outlines costs that the OPOs have designated as directly associated with each organ acquisition, including surgeon fees, transportation, medical supplies, laboratory tests, preservation, and importation costs. Second, we incorporate the various overhead costs per organ, found in Worksheet A (Reclassification and Adjustment of Trial Balance of Expenses). Overhead costs are allocated based on the relative number of organs procured, with this allocation ratio calculated in Worksheet B-1 (Cost Allocation – Statistical Basis). Finally, administrative and general costs are allocated according to the relative size of the subtotal cost, which includes both organ-specific costs and relative overhead charges from the preceding stages.

[22]For the full Tier ranking see pages 77929 and 77930 in CMS's final rule (42 CFR §486).

presents summary statistics for the total acquisition costs across all organs, with a specific focus on kidneys. These costs are derived from Form CMS 216-94 and include, among other items, support personnel expenses, surgeon fees, laboratory testing, and public and professional education. The table shows that the total acquisition cost for all OPOs increased from $1.03 billion in 2015 to $2.52 billion in 2024. The data also indicate that kidney-related acquisition costs account for approximately 60% of the total organ procurement costs. Specifically, at the OPO level, total annual acquisition costs ranged from an average of $20.2 million in 2015 to $51.4 million in 2024. The table also notes changes in the total number of OPOs resulting from mergers in both 2021 and 2023, each involving two organizations.

Figure 1, already discussed in the introduction, highlights the significant increase in total system costs and organs recovered after 2018. In both cases, kidneys are the primary driver of this growth. While in 2018 total costs associated with kidney procurement were under $700 million, by 2024 this figure had tripled. At the same time, the number of kidneys recovered rose from 20,000 in 2018 to over 30,000 in 2024. Positive trends in costs and recoveries are also observed among other organs, but none matchs the magnitude of the increase seen for kidneys, which motivates our analysis.

To characterize the evolution of the organ donation system, Figure 3 presents trends over time in the total number of donors (panel (a)), total organs recovered (panel (b)), and kidneys specifically (panel (c)). The patterns are clear: donor numbers increased at a moderate pace from 2011 through 2018, followed by a sharp increase in the number of donors. From 2018 to 2024, the number of donors rose by 59%—more than double the 24% growth observed between 2011 and 2018. Similarly, the total number of organs recovered grew by 51% in the later period, compared to 31% in the earlier years. Kidney recoveries showed the most pronounced increase, with a 63% rise between 2018 and 2024, compared to 33% previously. The variation across panels suggests that the CMS reform introduced in this period created targeted incentives for OPOs to engage more donors and increase organ procurement, particularly for kidneys.

Before proceeding with the formal evaluation of the reform's impact on organ recovery, we present panel (a) of Figure 4, which shows the monthly trends in the total number of kidneys recovered. The solid line depicts the trend estimated using a nonparametric regression model, while the dashed line shows the projected trend based on pre-reform data (prior to January 2019). The gap between these two curves illustrates the deviation attributable to the reform. Based on this analysis, we estimate that the total number of additional kidneys recovered—defined as the deviation from the pre-reform trend—between January 2019 and September 2024 amounts to 22,975 organs, representing a 17.32% increase relative to projected levels in the absence of the reform.

Panel (b) of Figure 4 presents an analogous graphical analysis for all other organs combined (circles), as well as disaggregated by organ type (heart, liver, lungs, and pancreas). The comparison between panels (a) and (b) illustrates the logic underpinning our identification strategy. Given the incentives introduced by the 2019 reform and the distinctive characteristics of kidneys, OPOs were likely to prioritize kidney procurement over other organs, a pattern consistent with the trends shown in the figure. Accordingly, we consider kidneys as the treated organ, with the remaining organs serving as the control group.

While our data do not allow for an input-level analysis by organ type, they do permit an examination of changes in, for example, staffing patterns within OPOs, the associated salary expenditures, administrative costs, and different overhead costs. Table 2 presents the evolution of the following variables that capture these dimensions: Total Full-Time Employees (TFE); Procurement Coordinators (PrC); Preservation Technicians and Other Operational Staff (PrT); Other Personnel—including Medical Directors, Administrative Medical Directors, Other Administrative Personnel, Executive Directors, and Clerical Staff (MeP); as well as overhead costs related to Procurement Coordinators (PCC); Total Procurement Costs (PRO); Administrative Costs (ADM), and Total Organ Acquisition Cost (OvC).[23] In each case, the table reports the coefficients for year indicators (with 2015 as the baseline) in the context of an event study-type of regressions in which we control for OPO fixed effects. To provide a basis for comparison, the table's last row reports the average of the respective dependent variable for the period 2015–2018.

The results reveal a substantial increase in most input categories and costs, particularly starting

[23] Our data includes information on *Administrative and General Costs*, which represent expenses associated with support personnel. These costs cover administration, accounting, medical director services, office salaries, and office professional education (sourced from Form CMS 216-94, Worksheet A1, titled "Admin and General Expenses", Column 3, labeled "Total"). *Overhead Costs* is an aggregate of several items. First, it includes costs from Form CMS 216-94, Worksheet B, titled "Cost Allocation", Column 2, labeled "Net Cost for Allocation", Row 2, titled "Organ Acquisitions". Second, it includes "Procurement Coordinators overhead" from Worksheet A, Column 7, labeled "Net Cost for Cost Allocation", Row 9, titled "Procurement Coordinators". Third, it includes "Public Education overhead" from Worksheet A, Column 7, Row 11, titled "Public Education". Finally, it includes "Professional Education overhead" from Worksheet A, Column 7, Row 10, titled "Professional Education". *Transplant Centers* captures the number of transplant centers to which the OPO provided organs in a given year, based on data provided by the United Network for Organ Sharing (`https://optn.transplant.hrsa.gov/data/view-data-reports/request-data/`). *Total Employees* measures the total number of employees at an OPO. This variable is drawn from Form CMS 216-94, Worksheet S1, Part 3, titled "Full Time Employees", Row 2, labeled "Total FTEs."

in 2019. By 2018, the total number of full-time OPO employees (Column 1) had increased by an average of 40 workers relative to 2015. By 2024, this figure had risen by 215%, reaching an average of 126.4 additional workers (relative to 2015). A similar pattern is observed for Procurement Coordinators (Column 2)–a critical group of employees responsible for the entire organ procurement process, from identifying potential donors to overseeing organ recovery and transportation. Their number increased from 1.7 additional coordinators in 2018 to 43.1 in 2024 (both also relative to 2015). For Preservation Technicians and Other Operational staff (Column 3), the pre-2019 declining trend reversed beginning in 2019. By 2023, the number of workers in this category had returned to levels comparable to those in 2015. Column 4 shows that, by 2024, the number of additional personnel (including medical staff) (relative to 2015) was 20% higher than in 2018.

These staffing patterns are consistent with trends in the four measures of costs. Relative to the increase observed between 2015 and 2018, the average additional costs (also relative to 2015) rose by 555% for procurement coordinators (Column 5), 566% for total procurement (column 6), 406% for administrative spending (column 7), and 556% for net organ acquisition costs (Column 8).

Figure 5 presents point estimates and associated confidence intervals from event-study–type regressions examining full-time personnel (panel (a)) and total procurement coordinator costs (panel (b)) across OPO tiers. Each panel reports the estimated coefficients for the 2018 and 2024 year indicators for both outcomes. The results highlight substantial tier-level differences in the additional number of full-time employees and increased procurement costs following the reform. In both cases, the magnitude of the coefficients indicates larger increases in Tiers 2 and 3 relative to Tier 1. For example, while procurement coordinator costs in Tier 1 OPOs had more than doubled by 2018 (relative to 2015), the increases were smaller in Tiers 2 and 3. By 2024, however, these differences had narrowed significantly. As we argue throughout the paper, the incentives introduced by the reform may help explain these distinctive trends. We examine these differences in greater detail below.

While we are cautious in interpreting these shifts as causal effects of the 2019 reform, the results suggest a potential impact of the legislation on OPO operations.

4 The impact on organ-related outcomes

In this section, we evaluate the impact of the reform on OPO productivity, measured by monthly organ recovery and transplantation volumes. In addition to productivity, we also examine the consequences of the new regulatory framework on the cost structures faced by OPOs. Our empirical strategy focuses on kidneys as the treatment organ, using all other organs—hearts, livers, lungs, and pancreases—as a control group to isolate the effect of the policy change. This focus on kidneys is motivated by their outsized role in the U.S. organ donation system. Kidneys account for approximately 60% of all transplants, making them central to OPO performance metrics. Their relatively long viability window (24–36 hours) also facilitates broader geographic allocation compared to other organs, which affects performance metrics. Moreover, Medicare fully reimburses kidney procurement efforts, even if they do not result in successful transplantation. This creates strong financial and operational incentives for OPOs to prioritize kidneys over other organs in the post-reform period.

Before presenting our main findings, we motivate our empirical strategy using Figure 6, which shows the evolution of the average number of kidneys and other organs recovered by OPOs from 2011 to 2024. It also displays the annual difference between the number of kidneys and other organs recovered, offering an initial view of our identification approach.

The figure reveals similar growth trends for both groups prior to the reform. From 2011 to 2017, the number of kidneys recovered increased from 14,780 to 18,684—a 26.41% growth. Over the same period, the number of other organs recovered rose from 14,071 to 17,741, reflecting a comparable increase of 26.08%. This parallel growth shows the similarity in the annual growth of the two groups and also the stability in the difference between the two groups during this time. Importantly, the figure reflects the overall expansion of the transplant market during this period, driven by increasing demand, improved clinical practices, and broader public awareness. As the need for organ transplants grew nationwide, OPOs responded with greater recovery efforts across all organ types. Thus, the observed upward trend in both kidney and non-kidney organ recoveries aligns with the general growth of the organ donation and transplantation ecosystem.

An uptick in kidney recoveries relative to other organs begins in 2018, suggesting that some OPOs may have anticipated the reform. From 2019 onward, the divergence becomes more pronounced.

Between 2018 and 2024, kidney recoveries increased by 63.15%, while other organs increased by only 31.15%. The widening gap in bar heights reflects this growing divergence, which is central to our analysis.

Given the economic incentives in place and the previous findings, we next quantify the reform's impact by estimating a Difference-in-Differences (DiD) model using observational data. We also explore dynamic effects using an extended two-way fixed-effects approach (Wooldridge, 2021). Formally, we exploit the data $\{y_{i(j),t}, d_{i(j),t}\}$ for time t, with $t = 1, .., T$, and unit $i(j)$, where j denotes the OPO and i the specific type of organ (kidney or all other organs). $y_{i(j),t}$ is the outcome of interest and $d_{i(j),t}$ is an indicator function that equals one if the unit is treated or zero otherwise at time t. Formally, we estimate the following model:

$$y_{i(j),t} = \alpha_{i(j)} + \gamma_t + \beta d_{i(j),t} + \epsilon_{i(j),t}, \tag{1}$$

where $\alpha_{i(j)}$ is the unit-level fixed effects and γ_t are time (year-month) fixed effects, and $\epsilon_{i(j),t}$ is the error term. Since the reform was implemented simultaneously across all OPOs, and our sample is close to a balanced panel—with annual cost data for approximately 50 OPOs and monthly organ data for 58 OPOs from 2013 to 2024—the coefficient β represents the parameter of interest. We rely on the parallel trends assumption and the absence of anticipatory behavior at the OPO level to interpret β as the average treatment effect on the treated (ATET) (Roth et al., 2023). To support these identifying assumptions, we construct event-study plots, examine the robustness of our results to various sample restrictions, and conduct formal statistical tests. Following standard practice, we use never-treated and not-yet-treated units as controls. We also explore heterogeneous effects by OPO tier, examining how differential exposure to the reform's underlying incentives triggered distinct organizational responses.

Table 3 presents the main results for the full sample (panel (a)). Column (1) shows that the average monthly number of kidneys recovered per OPO increased by 7.129 organs following the reform, a statistically significant effect representing an increase of nearly 30% relative to the pre-reform average of 24.78 kidneys per month. For transplanted kidneys, the average monthly increase is 2.8 organs, corresponding to a 10% rise. This implies that only 39.2% of the newly recovered kidneys were transplanted, compared to 80.9% prior to the reform – indicating how the reform's financial incentives operated. panel (a) also reports the results of the parallel trends tests. For both recovered and transplanted kidneys, the data support the validity of our empirical strategy.

Figure 7 illustrates the dynamic effects of the reform on kidneys recovered (panels (a) and (b)) and transplanted (panels (c) and (d)). Panel (a) shows that the monthly difference in kidney (treated organ) recoveries relative to other organs (control group) remained stable prior to 2019, with a clear divergence emerging in January 2019. After that point, the gap between the two series widened significantly, reaching a difference of more than ten organs by 2021. To highlight this pattern, Panel (b) presents the average monthly difference estimated using an event-study analysis implemented through a two-way fixed effects model. The figure reveals a growing and statistically significant divergence that eventually stabilizes around the same level—approximately ten additional kidneys per OPO.

Panels (c) and (d) replicate the analysis for transplanted kidneys. In this case, during the pre-reform period, the number of kidneys transplanted was lower than the number of other organs transplanted. This pattern reversed in 2019: from that year onward, more kidneys were transplanted than other organs. As panel (d) shows, although the magnitude of the effects is smaller than for recovered kidneys, the impact of the reform is in the same direction.

To assess the extent to which the estimated ATET may be influenced by the initial responses of OPOs to the reform, panels (b), (c), (d), and (e) of Table 3 present results from estimating equation (1) on different samples.

Panel (b) reports the findings when data from the first year of the reform (2019) are excluded. In this case, column (1) shows that the estimated impact on kidneys recovered is 8.132, which represents roughly one additional organ per OPO per month relative to the baseline estimate in panel (a). For transplanted organs (column (2)), the estimated effect is 3.135, also higher than the baseline point estimate. As expected, and consistent with the patterns shown in Figure 7, excluding the first year of the reform yields larger point estimates.

When data from 2020 are excluded (panel (c)), the point estimates again exceed those reported in panel (a) – 7.58 for recovered organs and 2.80 for transplanted organs – though they remain below those obtained when 2019 is excluded. Finally, when both 2019 and 2020 are excluded from the sample, the effects of the reform are the largest for both recovered and transplanted organs, consistent with a medium-term impact.

Finally, given the apparent uptick observed during 2018, as shown in Figure 6, panel (e) of Table 3 presents results obtained after excluding data from that year. Compared to the estimates in panel (a), we observe only modest increases in the effects for both recovered kidneys (6.9% relative to the full sample) and transplanted kidneys (0.3%), alleviating concerns about significant anticipatory actions by OPOs.

Importantly, across all these samples, we fail to reject the presence of parallel trends at conventional confidence levels for both recovered and transplanted organs. This provides further support for the validity of our empirical strategy.

4.1 Where are the extra kidneys coming from?

To understand how OPOs increased the number of recovered organs, specifically kidneys, following the 2019 reform, we examine the characteristics of the hospitals from which these organs originated.[24]

We classify hospitals into three categories based on their historical interaction with OPOs. First, *New hospitals* are defined as institutions with which OPOs established their first recorded interaction after January 2019. *Regular hospitals* are those that provided donors and organs in more than 50% of the months between January 2011 and December 2018, indicating sustained engagement prior to the reform. In contrast, *Occasional hospitals* are those that supplied donors and organs in fewer than 50% of the months during the same pre-reform period.

Figure 8 decomposes the total number of donors (panel (a)), recovered organs (panel (b)), and recovered kidneys (panel (c)) by hospital type. The results indicate that the post-reform increase in organ recovery is not attributable to new partnerships formed with hospitals after 2019. Instead, the data suggest that much of the observed growth in donors and recovered organs originates from hospitals with which OPOs had only occasional contact prior to the reform. This finding highlights a shift in OPO engagement strategies, whereby organizations intensified efforts in less frequently tapped sources rather than expanding into entirely new institutional relationships.

Figure 9 reinforces this interpretation by illustrating how the differential increase in kidney versus

[24] This analysis uses information on *Procurement Hospitals*, which refers to the hospitals from which the OPO procured organs in a given year, as provided by the United Network for Organ Sharing.

other organ recoveries is especially concentrated among hospitals categorized as "occasional" and "regular" partners. The trend is most pronounced among Tier 3 OPOs, which historically have underperformed relative to national benchmarks. The figure highlights that OPOs experienced significant gains in kidney recoveries from these mid- and high-frequency hospital partners. This pattern implies that reforms may have incentivized OPOs—particularly those with more room for performance gains—to optimize latent opportunities within their current hospital footprint, rather than seeking growth exclusively through new affiliations.

5 Cost consequences of the organ recovery expansion

Having established the reform's impact on organ recovery volumes, we now examine its consequences for OPO-reported costs. These costs, which are reported annually and disaggregated by organ type, enable us to analyze how financial resource allocation changed post-reform—particularly for kidneys compared to other organs.

Panel (a) of Figure 10 illustrates average annual OPO-level costs for kidney recovery versus other organs between 2015 and 2024. Prior to 2021, costs for both groups followed similar trajectories. However, starting in 2021—a year after the reform was finalized and just before implementation—kidney-related costs began rising more sharply. Specifically, average kidney-related costs increased from approximately \$16 million in 2020 to more than \$30 million by 2024, amounting to an 87.5% increase over four years. In contrast, costs for other organs grew modestly and steadily, with no evident structural break.

Panel (b) of Figure 10 supports this divergence through a dynamic difference-in-differences analysis, showing a significant and growing average treatment effect on the treated (ATET) for kidney-related costs relative to other organs. By the third year after the reform's announcement, this relative increase amounted to approximately \$5 million per OPO, and doubled to approximately \$10 million within the subsequent two years, in 2024.

To evaluate the intensity of cost growth per recovered organ, panels (c) and (d) of Figure 10 present the trends in per-organ costs. While the absolute costs per kidney do rise post-reform, the increase largely mirrors the volume growth—suggesting that the rise in total kidney-related costs is a near-linear function of expanded procurement activity, rather than inflated per-unit expenses.

Table 4 reports regression estimates of the average annual cost impact. Panel (a) presents results for total annual OPO-level costs. Using the full sample (column 1), the reform is estimated to increase total costs by \$3.85 million per OPO per year, statistically significant at the 5 percent level. Excluding 2019 (column 2) raises the estimate to \$4.62 million, while excluding 2020 (column 3) yields \$4.75 million. When both 2019 and 2020 are excluded (column 4), the estimated effect increases to \$5.99 million, consistent with growing divergence in later post-reform years. In all specifications, we fail to reject the null of parallel pre-trends at conventional levels, supporting again the validity of the identification strategy.

Panel (b) reports estimates using costs per organ as the outcome. The point estimates are positive and increase when early treatment years are excluded, but they are not statistically distinguishable from zero. Accordingly, the aggregate cost effects documented in panel (c) cannot be attributed to higher per-organ costs. Instead, the evidence suggests that cost escalation primarily reflects increased volumes, facilitated by financial incentives and regulatory pressure.

5.1 Back-of-the-envelope cost-benefit analysis

In Section 3, we quantify the monthly increase in kidneys recovered after the 2019 reform by calculating the difference between the total reported number of kidneys and the estimated trend based on pre-reform data (see Figure 6). To estimate the corresponding social benefit, we repeat the analysis for transplanted kidneys and combine the resulting figures with the average annual public cost of dialysis per patient during the period covered by our sample. Since other potential benefits are excluded, this proxy provides a conservative estimate.

According to United States Renal Data System (2023), the annual per capita Medicare fee-for-service spending (in 2021 dollars) for beneficiaries with End-Stage Renal Disease (ESRD) was \$83,390 in 2019, \$80,554 in 2020, and \$82,167 in 2021. In the absence of more recent estimates, we apply the 2021 figure to the period spanning 2022 to 2024. On the other hand, the estimated annual number of additional kidney transplants during this period is as follows: 1,074 (2019), 1,233 (2020), 1,607 (2021), 1,749 (2022), 2,421 (2023), and an estimated value of 2,254 (2024).[25] Using these figures and accounting for the stream of savings generated by each additional kidney transplanted

[25] In 2024, a total of 1,786 kidney transplants were performed between January and September. To project the figure through December, we first compute the average monthly number of transplants during the third quarter of 2024 and then extrapolate this value (156 transplants) to the final three months of the year.

between January 2019 and December 2024, we estimate that the reduction in aggregate dialysis demand results in total savings of approximately \$2,165 million.[26]

Conversely, the reform also led to higher government expenditures, both due to implementation costs and its effect on the number of organs recovered—specifically, kidneys. To account for this, we perform a parallel exercise to the one used for estimating kidney-related savings, this time applied to total costs per Organ Procurement Organization (OPO).

The results are presented in Figure 11. As in Figure 6, cost projections are based on a linear model with a year trend as the independent variable, estimated using pre-2019 data. The annual differences between observed and predicted OPO-level costs indicate that the reform generated additional expenditures of \$38.34 million in 2019, \$30.43 million in 2020, \$212.02 million in 2021, \$354.81 million in 2022, \$495 million in 2023, and \$617.26 million in 2024.[27] In total, these figures amount to \$1,587.84 million in additional spending (in 2021 dollars). Based on our saving estimates for the 2019–2024 period, the net fiscal effect of the reform corresponds to overall savings of \$577 million.

6 Performance Tiers: Incentives and Responses

Given the design of the CMS reform and its reliance on a tiered performance evaluation system, OPOs responded differently depending on their assigned Tier. This section examines the heterogeneous effects of the 2019 policy change on kidney recovery, transplantation, and cost outcomes across Tiers 1, 2, and 3.

6.1 Organ outcomes

Across all tiers, kidney recoveries increase following the reform, although the timing and magnitude of the response vary systematically. Monthly trends and event-study estimates show that Tier 2 OPOs exhibit the sharpest and earliest growth, while Tiers 1 and 3 respond more gradually

[26] The estimated savings reflect the cumulative reduction in dialysis spending from the month of each transplant through the end of the sample. For instance, for kidneys transplanted in January (February) 2019, savings are calculated through December 2024, covering 72 (71) months. To do so, we compute monthly per capita Medicare spending from the corresponding annual figure.

[27] For 2024, the number of organs is annualized based on data covering January to September.

(Figure 12). In all three tiers, recovery trajectories level off around 2022, suggesting that it took approximately three years for OPOs to fully adjust to the new regulatory environment.[28]

Average treatment effects reinforce these patterns. As summarized in Table 5, the reform significantly increased the number of kidneys recovered in every tier, with the largest gains observed among Tier 2 OPOs (8.7 additional kidneys per month), followed by Tier 1 (7.4) and Tier 3 (6.0) (panel (a)). All estimated effects are statistically significant. For Tier 2, however, the parallel-trends assumption is rejected at conventional levels (p-value = 0.0506), indicating potential anticipatory behavior or divergent pre-trends within this group. This pattern is consistent with the incentives faced by OPOs operating near the performance thresholds defining Tier 2.[29]

While procurement activity increased across all tiers, gains in transplantation were more uneven. Higher-performing OPOs in Tiers 1 and 2 experienced statistically significant increases in transplanted organs, whereas estimated effects for Tier 3 were not statistically meaningful, as reported in panel (b) of Table 5. This divergence suggests that although lower-performing OPOs expanded recovery efforts, capacity or systemic constraints limited their ability to translate additional recoveries into successful transplants.

To explore the source of new organs and tier-level differences, Figure 13 examines hospital interaction patterns. Differences in the number of kidneys and other organs recovered annually increase sharply after 2020 across all tiers. Pre-reform trends are stable in Tiers 1 and 3, while Tier 2 exhibits signs of anticipatory behavior, with a noticeable increase in 2018 relative to 2017. Across all tiers, the relative growth in kidney recoveries is largely driven by hospitals with which OPOs had only occasional pre-reform interactions.[30]

[28] Appendix Table A1 documents the evolution of OPO-level average monthly donors from 2011 to 2023 by tier and shows an upward-sloping trend that accelerates sharply after 2019 across all groups.

[29] Following the analysis in Table 3, we estimate ATETs by tier excluding 2018. The resulting point estimates—7.496 for Tier 1, 8.972 for Tier 2, and 6.116 for Tier 3—are marginally larger than those reported in panel (a) of Table 5. All three estimates are statistically significant at the 1% level, and the null of parallel trends cannot be rejected for any tier in the restricted sample. Despite this, we favor the more conservative full-sample estimates reported in Table 5.

[30] Appendix Figures A1 and A2 further document differences by tier and hospital type.

6.2 Cost outcomes

Cost patterns mirror these differences. Prior to 2019, differences in costs between kidneys and other organs remain stable across tiers. After the reform, costs rise sharply, particularly in Tiers 1 and 2, where kidney-related costs eventually overtake those associated with other organs (Figure 14). Regression-based estimates indicate positive treatment effects in all tiers, with the largest and statistically significant increase—nearly \$15 million annually—occurring among Tier 1 OPOs. Although estimated effects for Tier 3 are also positive and sizable, they are not statistically distinguishable from zero at the 5 percent level, reflecting a more muted response during the early post-reform years.

Estimated cost effects are sensitive to the inclusion of early reform years. In the full sample, Table 6 reports average annual increases between \$3.1 and \$4.6 million, with statistically significant effects in Tiers 1 and 3, although the parallel-trends assumption is rejected for Tier 1 (panel (a)). Excluding data from 2019 and 2020 yields larger and more precisely estimated effects across tiers. When both years are omitted, estimated annual impacts rise to \$8.0 million for Tier 1, \$5.7 million for Tier 2, and \$4.2 million for Tier 3, all statistically significant at least at the 10 percent level.[31]

6.3 Diversification or Specialization?

In multiproduct settings, economies or diseconomies of scope arise when joint production decreases or increases costs relative to more specialized production. Because OPOs can be understood as multi-output geographical monopolies, we use the incentives generated by the CMS reform to study how regulatory pressure affects the scope of their production.

Thus, following Baumol et al. (1982), consider a multi-output monopolist producing n goods with output vector $\mathbf{q} = (q_1, \ldots, q_n)$. Let $p_i(\mathbf{q})$ denote the (possibly interdependent) inverse demand function for product i, and let the cost of producing $\mathbf{q}$ be given by a twice continuously differentiable, strictly increasing cost function $C = C(\mathbf{q}; \mathbf{w})$, where $\mathbf{w}$ is the vector of input prices. The monopoly

[31] Appendix Table A2 reports corresponding estimates for annual costs per organ. While none are statistically significant, point estimates become more positive when early reform years are excluded.

chooses $\mathbf{q}$ to maximize profits,

$$\pi(\mathbf{q}) = \sum_{i=1}^{n} p_i(\mathbf{q})q_i - C(\mathbf{q}; \mathbf{w}).$$

Given our context, we focus on the two-output case, $n = 2$ (kidneys versus other organs), with output vector (q_1, q_2). The standard measure of scope at (q_1, q_2) is

$$SC(q_1, q_2) = \frac{C(q_1, 0; \mathbf{w}) + C(0, q_2; \mathbf{w}) - C(q_1, q_2; \mathbf{w})}{C(q_1, q_2; \mathbf{w})}.$$

Under standard regularity conditions, economies and diseconomies of scope can also be characterized locally by the cross-partial derivative of the cost function, $\frac{\partial^2 C}{\partial q_1 \partial q_2}(q_1, q_2; \mathbf{w})$. Intuitively, a negative value of this term implies that increasing q_1 reduces the marginal cost of q_2, indicating local economies of scope, whereas a positive value implies that increasing q_1 raises the marginal cost of q_2, indicating local *diseconomies* of scope.

A central challenge in the empirical literature is how to test for scope effects. Much of the existing work relies on cost complementarities—negative cross-partials of the cost function—as a sufficient condition for economies of scope. However, this criterion is neither necessary nor robust in high-dimensional output spaces. As a result, rejecting cost complementarities does not, by itself, imply diseconomies of scope. To address this limitation, Preyra and Pink (2006) advocate a direct approach that compares the predicted cost of diversified production to counterfactual specialization while holding aggregate output fixed, emphasizing that scope effects depend on both the output bundle and the margin of specialization considered. We build on this insight by first adopting a difference-in-differences strategy to examine whether the CMS reform generates incentives for OPOs to specialize (diseconomies of scope) or to diversify (economies of scope) their production. Our strategy leverages pre-reform production patterns to construct counterfactuals for specialization and diversification using a flexible functional form for the cost function:

$$C_{it}(q_1, q_2; \mathbf{w}) = \alpha_0 + \alpha_1 q_{1,i,t} + \alpha_2 q_{2,i,t} + \alpha_3 D_t + \alpha_{12} q_{1,i,t} q_{2,i,t} + \alpha_{13} D_t q_{1,i,t} q_{2,i,t} + \tau_t + \gamma_i + \epsilon_{i,t}, \quad (2)$$

where τ_t and γ_i denote time and OPO fixed effects, respectively, which absorb common input prices $\mathbf{w}$. The binary variable D_t equals one after the reform is implemented (zero otherwise).

Accordingly, our parameter of interest is α_{13}. [32]

Table 7 presents our findings. The estimates associated with the triple interaction provide clear evidence of diseconomies of scope following the policy change. The coefficient is positive and statistically significant in the full sample and, importantly, across Tiers 1 and 2, indicating that the marginal cost interaction between kidneys and other organs becomes less favorable after the reform. This pattern is most pronounced for Tier 2 OPOs, where the estimated coefficient is large (0.429) and precisely estimated, consistent with the expectation that organizations in this group were more strongly affected by the reform. The estimate implies that, for Tier 2 OPOs, producing one additional kidney and one additional non-kidney organ after the reform increases total costs by approximately \$0.429 beyond the sum of their separate marginal costs, reinforcing incentives to specialize rather than to jointly expand across organ types and cutting almost in half the magnitude of the pre-reform economies of scope (α_{12}). In contrast, Tier 3 OPOs exhibit a small and statistically insignificant coefficient, indicating weaker or absent specialization incentives in that segment.

To further explore the dynamic consequences of the reform on Tier 2 OPOs, Figure 15 reports year-specific coefficients for the $q_1 \times q_2$ interaction from a regression analogous to equation (2), in which the binary reform indicator D_t is replaced by a full set of year dummies. Consistent with previous results, the reform appears to have strengthened incentives toward specialization within Tier 2 OPOs. The estimated interaction effects rise steadily following the announcement, reaching approximately one dollar by 2020.

Finally, we construct observation-level measures of the implied cost of specialization versus diversified production for Tier 2 OPOs using regression (2). Let $\widehat{\text{Cost}}_{it}$ denote the predicted value, including all fixed effects. We then construct an observation-level "baseline" term that collects the fitted component of cost not mechanically attributable to the three output terms $(q_{1,it}, q_{2,it}, q_{1,it}q_{2,it})$:

$$\widehat{\text{base}}_{it} \equiv \widehat{\text{Cost}}_{it} - \widehat{\alpha_1} q_{1,i,t} - \widehat{\alpha_2} q_{2,i,t} - \widehat{\alpha_3} D_t - \widehat{\alpha_{12}} q_{1,i,t} q_{2,i,t} - \widehat{\alpha_{13}} D_t q_{1,i,t} q_{2,i,t}.$$

The counterfactual cost of specializing fully in kidneys while keeping total output fixed can then

[32] Our identification relies on the assumption that, absent the reform, the evolution of cost interactions between outputs would have followed similar trends across OPO tiers. A limitation is that unobserved contemporaneous shocks—such as changes in donor composition or local input markets—could also affect estimated scope parameters, although the event-study evidence below mitigates this concern.

be approximated by:

$$\widehat{C}_{it}^{K} \equiv \widehat{\text{base}}_{it} + \widehat{\alpha}_1 Q_{it},$$

where $Q_{it} = q_{1,i,t} + q_{2,i,t}$. Likewise, specializing fully in other organs implies counterfactual costs of the form:

$$\widehat{C}_{it}^{O} \equiv \widehat{\text{base}}_{it} + \widehat{\alpha}_2 Q_{it}.$$

These counterfactuals compare diversified production with two single-output configurations that keep the total quantity Q_{it} constant. Based on these expressions, we define the cost penalty of specializing in kidneys and other organs relative to diversified production as:

$$\begin{aligned} \text{penK}_{it} &\equiv \widehat{C}_{it}^{K} - \widehat{\text{Cost}}_{it}, \\ \text{penO}_{it} &\equiv \widehat{C}_{it}^{O} - \widehat{\text{Cost}}_{it}, \end{aligned}$$

where a positive value of penK_{it} (penO_{it}) indicates that kidney-only (other-organ-only) specialization is more costly than producing the observed mix, whereas a negative value indicates that specialization is cheaper than diversification. To summarize the implied incentive to specialize, we define a "best specialization" measure as:

$$\text{Best}_{it} \equiv \min\{\text{penK}_{it}, \text{penO}_{it}\},$$

where Best_{it} captures the least-cost specialization option; when Best_{it} is negative, specialization dominates diversification at the fitted values, implying stronger incentives to concentrate production in a single output.

Figure 16 reports the yearly average Best_{it} for the pre- and post-reform periods within Tier 2, together with the 10th and 90th percentiles from OPO-clustered bootstrap replications. The movement toward more negative values after the reform indicates a deterioration in the implied scope metric: the estimated cost advantage of diversification declines, and incentives to specialize strengthen. This pattern is consistent with growing diseconomies of scope in Tier 2 OPOs following the reform.

7 Conclusions

This study provides the first comprehensive evidence on the effects of the 2019 CMS reform targeting the U.S. organ procurement industry. The reform aimed to address long-standing inefficiencies by replacing inconsistent, self-reported metrics with standardized, independently verified measures, specifically, donation and transplantation rates (Goldberg et al., 2019; Lentine and Mannon, 2020). A key ingredient of the reform was the introduction of a tiered performance ranking system that classifies OPOs based on comparative performance. Under this framework, high-performing OPOs receive automatic recertification, while lower-tier OPOs face increased oversight or potential decertification, thereby creating direct incentives for improved outcomes.

To evaluate the reform's impact, we leverage data sources central to the CMS evaluation process and supplement them with additional information, including a unique FOIA-obtained dataset of standardized cost reports. Using a difference-in-differences approach and data spanning for most of a decade, we isolate the causal effect of the reform on organ recovery outcomes.

Our findings suggest that the reform significantly boosted organ procurement activity, particularly kidneys. We estimate that the policy led to an average monthly increase of 7.129 recovered organs per OPO, relative to a baseline mean of 24.3 organs per OPO per month in the control group during the post-2019 period. These gains were driven primarily by strengthened relationships with existing hospitals, rather than the formation of new partnerships. Importantly, growth was concentrated among lower-tier OPOs, those most at risk of decertification under the new framework. Furthermore, the increase in organ recovery was accompanied by significant increases in costs, particularly for the lowest-performing OPOs. We also estimate that the reform was associated with a $2.165 billion reduction in aggregate dialysis costs, a substantial fiscal impact on the healthcare system. After accounting for the corresponding increase in OPO operational spending, we estimate net savings of approximately $577 million to the U.S. taxpayer through 2024.

In addition to its effects on procurement performance and costs, the reform also influenced how OPOs allocate effort across organ types. We find evidence that regulatory pressure increased diseconomies of scope, especially among Tier 2 OPOs, weakening pre-reform cost complementarities between kidneys and other organs. This suggests that part of the response to the reform occurred through changes in the internal organization of production.

These improvements are consistent with the reform's goal of strengthening accountability through standardized performance metrics. At the same time, rising OPO costs, particularly among lower-tier organizations, and stronger incentives to specialize raise concerns about the financial sustainability of these gains and their longer-run implications, including consolidation or reduced organizational diversity. Overall, the evidence suggests that well-designed performance-based regulation can improve efficiency and outcomes in complex, monopolistic healthcare markets, though careful monitoring is essential to avoid unintended structural imbalances. Future research should evaluate the downstream operational and financial consequences of the reform, including how changes in procurement activity affect long-term transplant outcomes, OPO financial stability, and hospital-OPO dynamics. Additionally, regulators may consider placing greater emphasis on improving recovery rates for non-renal organs, ensuring that performance gains extend across all organ types and not just kidneys.

8 References

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Table 1: Summary Statistics

Year	Number of OPOs	Costs (MMUS$)							
		Total		Mean		Min.		Max.	
		All	Kidney	All	Kidney	All	Kidney	All	Kidney
2015	51	1,028.47	504.14	20.17	9.89	4.04	2.14	62.43	36.97
2016	51	1,117.86	548.37	21.92	10.75	4.50	2.56	66.12	38.30
2017	51	1,224.41	594.31	24.01	11.65	4.42	2.81	71.45	43.37
2018	51	1,327.07	637.81	26.02	12.51	4.49	2.74	74.79	50.04
2019	51	1,477.74	721.24	28.98	14.14	4.33	2.92	85.01	58.09
2020	51	1,577.69	758.03	30.94	14.86	4.47	3.39	93.33	51.87
2021	50	1,841.90	969.17	36.84	19.38	4.72	3.63	100.85	50.09
2022	50	2,097.96	1,155.78	42.81	23.12	8.52	3.74	111.42	63.89
2023	49	2,347.66	1,322.78	47.91	26.99	5.32	4.04	133.31	78.64
2024	49	2,517.39	1,488.08	51.37	30.36	6.03	4.48	133.31	86.93

Note: Total costs represent the annual aggregate across all OPOs. Mean, minimum, and maximum costs reflect OPO-level annual averages, minimums, and maximums, respectively. From 2015–2020: Tier 1 = 20 OPOs, Tier 2 = 11, Tier 3 = 20. From 2021–2022: Tier 2 = 10 OPOs. In 2023-2024: Tier 3 = 19 OPOs.

Table 2: The Evolution of OPO Personnel and Monetary Costs: Yearly trend, 2016-2024

Year	Personnel				Costs			
	TFE	PrC	PrT	MeP	PCC	PRO	ADM	OvC
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2016	25.25**	-0.520	-14.93*	40.63***	532.6	679.5	530.2	608.1
	(10.48)	(4.131)	(8.161)	(13.94)	(518.6)	(627.6)	(485.4)	(581.3)
2017	29.17***	1.993	-17.05**	43.98***	943.6**	1,279***	854.4**	1,263***
	(10.48)	(4.131)	(8.161)	(13.94)	(518.6)	(627.6)	(485.4)	(581.3)
2018	40.54***	1.740	-16.62**	55.65***	1,613***	1,973***	1,522***	1,866***
	(10.48)	(4.131)	(8.161)	(13.94)	(518.6)	(627.6)	(485.4)	(581.3)
2019	39.67***	5.100	-16.04*	49.12***	2,290***	2,848***	1,985***	2,598***
	(10.48)	(4.131)	(8.161)	(13.94)	(518.6)	(627.6)	(485.4)	(581.3)
2020	47.43***	12.86***	-11.48	44.38***	2,702***	3,157***	2,436***	3,005***
	(10.48)	(4.131)	(8.161)	(13.94)	(518.6)	(627.6)	(485.4)	(581.3)
2021	55.91***	15.75***	-9.246	48.08***	3,824***	4,580***	3,237***	4,310***
	(10.54)	(4.155)	(8.209)	(14.02)	(521.6)	(631.3)	(488.3)	(584.7)
2022	73.63***	21.84***	-0.878	51.52***	5,570***	7,045***	4,834***	6,418***
	(10.54)	(4.205)	(8.209)	(14.02)	(521.6)	(631.3)	(488.3)	(584.7)
2023	99.94***	35.66***	0.127	61.75***	8,115***	10,138***	5,834***	9,389***
	(10.60)	(4.230)	(8.256)	(14.10)	(524.6)	(634.9)	(491.1)	(588.1)
2024	126.40***	43.10***	9.347	66.92***	10,562***	13,154***	7,712***	12,256***
	(10.60)	(4.230)	(8.256)	(14.10)	(524.6)	(634.9)	(491.1)	(588.1)
Obs.	504	498	504	504	504	504	504	504
R-squared	0.932	0.806	0.492	0.869	0.874	0.893	0.938	0.883
$\bar{y}$ (2015-18)	141.8	32.26	40.94	63.59	5,356	8,117	7,196	7,139

Notes: The table displays the estimated $\{\beta_t\}_{t=2016}^{2023}$ obtained from $y_{jt} = \alpha + \sum_{t=2016}^{2023} \beta_t D_t + \alpha_j + \mu_{jt}$, where $\{D_t\}_{t=2016}^{2023}$ is a set of year indicators and α_j represents OPO fixed-effects. The year 2015 is used as baseline. The columns denote: (1) TFE: Total Full Time Employees , (2) PrC: Number of Procurement Coordinators, (3) PrT: Number of Preservation Technician and Other Operational Employees, (4) MeP: Number of Medical Directors, Medical Director Administrative Personnel, Executive Director Administrative Personnel, Clerical Administrative Personnel, and Other Administrative Personnel, (5) PCC: Procurement Coordinators Cost, (6) Procurement (PRO): Procurement Coordinators Cost, Professional Education Cost, Public Education Cost, Other Acquisition Cost , (7) Administrative (ADM): Administrative General Costs, Employee Benefits, Housekeeping Spending, Other Administrative Overhead Cost, (8) OvC: Total Organ Acquisition Overhead Cost. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3: The impact of the reform on OPO-level organs

Organs:	Recovered (1)	Transplanted (2)
A. Full Sample		
DiD	7.129***	2.795***
	(1.195)	(0.901)
Observations	16,208	16,208
$\bar{Y}$: Control group in pretreatment period	23.267	21.533
$\bar{Y}$: Treatment group in pretreatment period	24.781	20.054
H_0 : Parallel trend (p-value)	0.422	0.681
B. Excluding 2019		
DiD	8.132***	3.135***
	(1.300)	(0.966)
Observations	14,818	14,818
H_0 : Parallel trend (p-value)	0.422	0.680
C. Excluding 2020		
DiD	7.580***	2.795***
	(1.306)	(0.981)
Observations	14,816	14,816
H_0 : Parallel trend (p-value)	0.422	0.680
D. Excluding 2019 and 2020		
DiD	8.989***	3.230***
	(2.241)	(1.095)
Observations	13,426	13,426
H_0 : Parallel trend (p-value)	0.406	0.704
E. Excluding 2018		
DiD	7.624***	2.804***
	(1.268)	(0.967)
Observations	14,818	14,818
$\bar{Y}$: Control group in pretreatment period	22.708	20.984
$\bar{Y}$: Treatment group in pretreatment period	24.086	19.496
H_0 : Parallel trend (p-value)	0.660	0.459

Note: The table reports the estimated coefficient β from equation (1), using monthly data on recovered and transplanted organs at the OPO level across different samples. Panel (a) reports results for the full sample; panel (b) excludes data from 2019, and panel (c) excludes 2018. “Kidneys” constitutes the treatment group, while “Other Organs” serves as the control group. The treatment period begins in January 2019. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 4: The impact of the reform on OPO-level costs

Sample:	Full	Excluding 2019	Excluding 2020	Excluding 2019 and 2020
	(1)	(2)	(3)	(4)
		A. Total costs (MMUSD)		
DiD	3.825**	4.629***	4.735***	5.995***
	(1.180)	(1.355)	(1.320)	(1.589)
H_0 : Parallel Trend (p-value)	0.269	0.269	0.269	0.281
$\bar{Y}$: Control group in pretreatment period			11.829	
$\bar{Y}$: Treatment group in pretreatment period			11.199	
		B. Cost per organ (USD)		
DiD	20.97	55.38	102.7	168.4
	(132.7)	(152.4)	(143.3)	(152.4)
H_0 : Parallel Trend (p-value)	0.596	0.596	0.569	0.587
$\bar{Y}$: Control group in pretreatment period			3,284	
$\bar{Y}$: Treatment group in pretreatment period			3,018	
Observations	1,007	905	905	803

Note: The table reports the estimated coefficient β from equation (1), using annual data on total procurement costs (panel (a)) and costs per organ (panel (b)) at the OPO level across different samples. "Kidneys" constitutes the treatment group, while "Other Organs" serves as the control group. The treatment period begins in January 2019. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Heterogeneous Effects by Tier
The impact of the reform on organs

Variables	Tier 1 (1)	Tier 2 (2)	Tier 3 (3)	Overall (4)
		A. Recovered		
DiD	7.414***	8.705***	5.996***	7.129***
	(1.873)	(2.431)	(2.047)	(1.195)
$\bar{Y}$: Control group in pretreatment period	28.041	23.688	17.817	23.267
$\bar{Y}$: Treatment group in pretreatment period	29.789	24.615	19.395	24.781
H_0 : Parallel Trend (p-value)	0.849	0.0506	0.584	0.422
		B. Transplanted		
DiD	3.243**	3.900**	1.733	2.795***
	(1.428)	(1.780)	(1.542)	(0.901)
$\bar{Y}$: Control group in pretreatment period	25.768	22.327	16.468	21.53
$\bar{Y}$: Treatment group in pretreatment period	23.971	20.211	15.684	20.054
H_0 : Parallel Trend (p-value)	0.502	0.473	0.927	0.681
Observations	6,726	3,286	6,196	16,208

Notes: The table reports the estimated coefficient β from equation (1), using monthly data on recovered (panel (a)) and transplanted (panel (b)) organs at the OPO level, disaggregated by Tier. “Kidneys” constitute the treatment group, while “Other Organs” serve as the control group. The treatment period begins in January 2019. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Heterogeneous Effects by Tier
The impact of the reform on OPO-level costs

Tiers:	Tier 1 (1)	Tier 2 (2)	Tier 3 (3)
	A. Full sample		
DiD	4.606***	3.173	3.121**
	(2.195)	(2.509)	(1.422)
H_0 : Parallel Trend (p-value)	0.0261	0.946	0.297
Observations	396	212	399
	B. Excluding 2019		
DiD	5.846***	4.429	3.540**
	(2.514)	(2.871)	(1.651)
H_0 : Parallel Trend (p-value)	0.0261	0.946	0.297
Observations	356	190	359
	C. Excluding 2020		
DiD	6.083***	4.507	3.533**
	(2.951)	(2.735)	(1.615)
H_0 : Parallel Trend (p-value)	0.0261	0.946	0.297
Observations	356	190	359
	D. Excluding 2019 and 2020		
DiD	8.023***	5.696*	4.162**
	(2.951)	(3.294)	(1.961)
H_0 : Parallel Trend (p-value)	0.0261	0.994	0.298
Observations	316	168	319
$\bar{Y}$: Control group in pretreatment period	14.93	13.11	8.018
$\bar{Y}$: Treatment group in pretreatment period	13.20	11.46	9.051

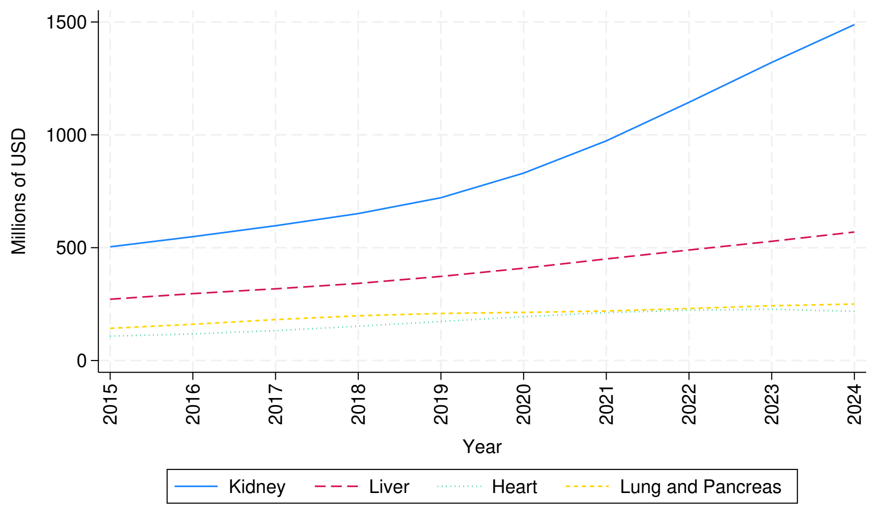
Notes: The table reports the estimated coefficient β from equation (1), using annual information on procurement costs at the OPO level, disaggregated by Tier, across different samples. Panel (a) reports results for the full sample; panel (b) excludes data from 2019, and panel (c) excludes 2018. "Kidneys" constitute the treatment group, while "Other Organs" serve as the control group. The treatment period begins in January 2019. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Testing for diseconomies of scope as a result of the CMS reform
Dependent variable: Total OPO costs (dollars of 2024)

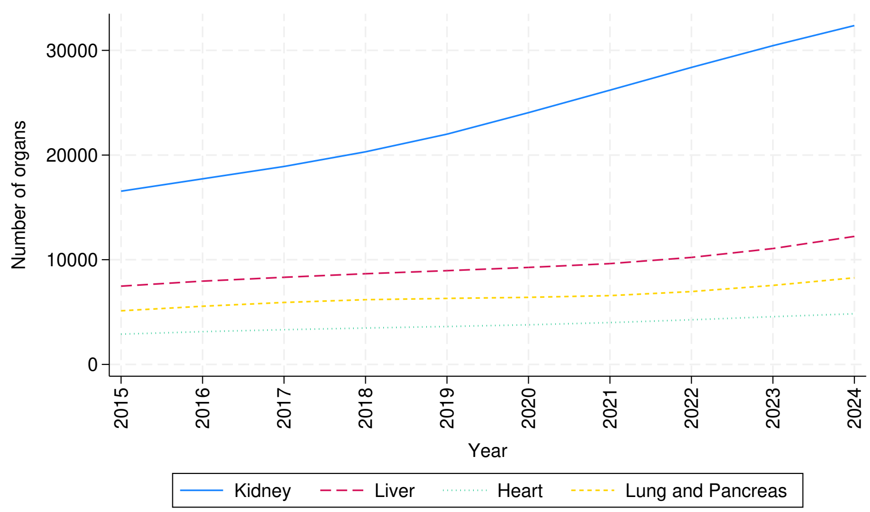
	Full Sample	**Tier 1**	**Tier 2**	**Tier 3**
q_1 (Kidneys)	8885.2***	8700.5***	4979.2**	9440.1***
	(872.2)	(1395.5)	(2213.3)	(1429.5)
q_2 (Other organs)	485.4	2215.5	-2327.4	1917.8
	(1072.0)	(1742.6)	(3174.8)	(1610.8)
$q_1 \times q_2$	-0.561***	-0.677***	-0.843**	-0.376**
	(0.099)	(0.147)	(0.322)	(0.172)
$D \times q_1 \times q_2$	0.145***	0.190***	0.429***	0.004
	(0.028)	(0.041)	(0.115)	(0.050)
Observations	503	198	106	199
R-squared	0.947	0.937	0.964	0.936

Notes: Each column reports results from a separate OLS regression. All models include OPO fixed effects and year fixed effects (coefficients omitted). Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Figure 1: The Evolution of Costs and Recovered Organs, 2015-2024



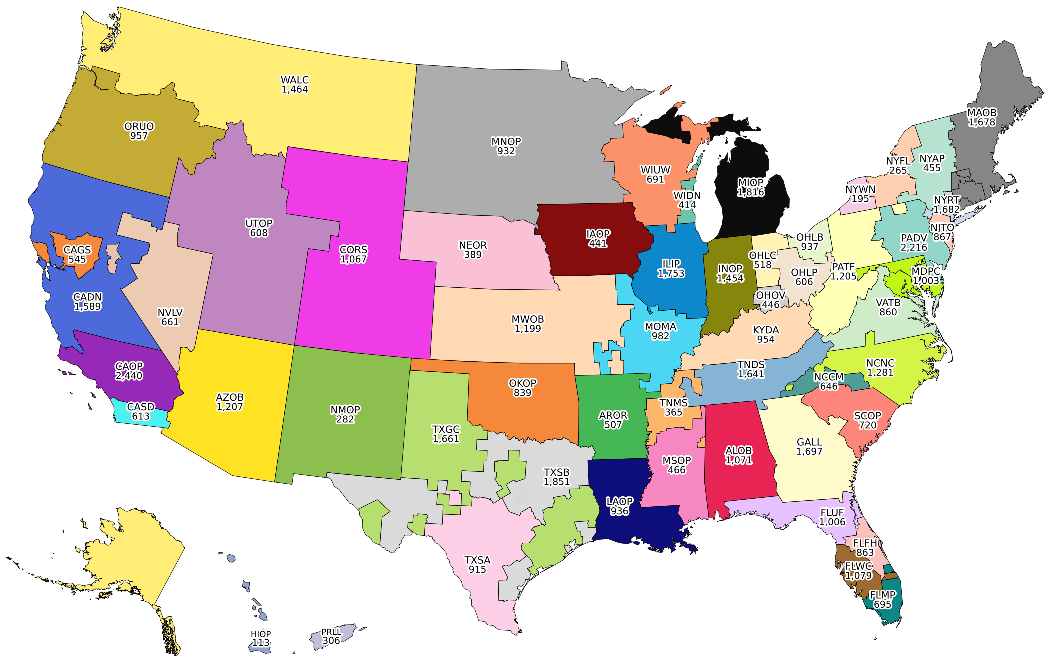
(a) Annual Costs by Organ



(b) Total Recovered Organs

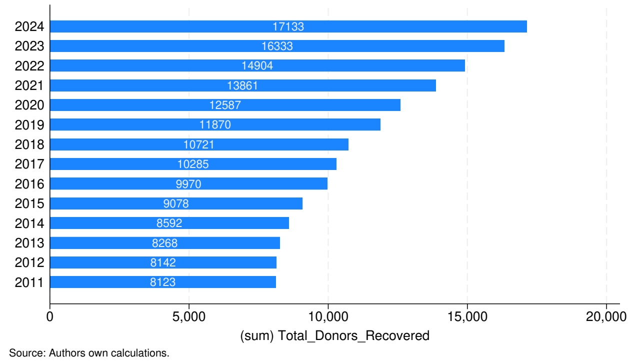
Note: Panel (a) displays total annual costs by organ, aggregated across Organ Procurement Organizations (OPOs) from 2015 to 2024. Panel (b) displays the total number of recovered organs for each year. For 2024 (panel (b)), we annualize the total number of organs based on data available through September, the most recent month reported.

Figure 2: Geographical Distribution of Organ Procurement Organizations across the U.S., 2023

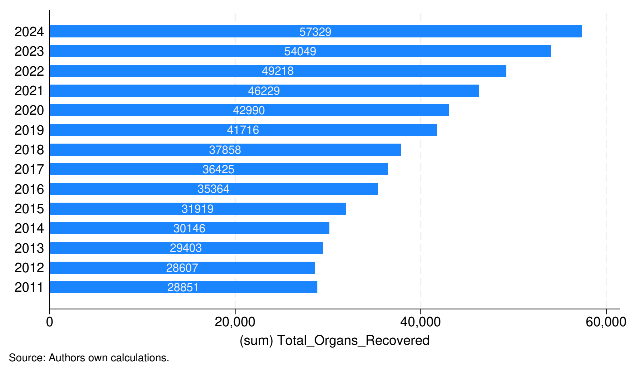


Note: The figure presents the distribution of OPOs across the U.S., including the total number of organs recovered during 2023. The following is the lists of OPOs: ALOB – Legacy of Hope (Alabama); AROR – Arkansas Regional Organ Recovery Agency; AZOB – Donor Network of Arizona; CADN – Donor Network West (California); CAGS – Sierra Donor Services (California); CAOP – OneLegacy (Los Angeles, CA); CASD – Lifesharing (San Diego, CA); CORS – Donor Alliance (Colorado); FLFH – OurLegacy (Florida, Orlando); FLMP – Life Alliance Organ Recovery Agency (Miami, FL); FLUF – LifeQuest Organ Recovery Services (Florida, Gainesville); FLWC – LifeLink of Florida (Tampa, FL); GALL – LifeLink of Georgia; HIOP – Legacy of Life Hawai'i; IAOP – Iowa Donor Network; ILIP – Gift of Hope Organ & Tissue Donor Network (Illinois); INOP – Indiana Donor Network; KYDA – Kentucky Organ Donor Affiliates; LAOP – Louisiana Organ Procurement Agency; MAOB – New England Donor Services; MDPC – Infinite Legacy (Maryland); MIOP – Gift of Life Michigan; MNOP – LifeSource (Minnesota); MOMA – Mid-America Transplant (Missouri); MSOP – Mississippi Organ Recovery Agency; MWOB – Midwest Transplant Network (Kansas); NCCM – LifeShare Carolinas (Charlotte, NC); NCNC – HonorBridge (Durham, NC); NEOR – LiveOn Nebraska; NJTO – NJ Sharing Network; NMOP – New Mexico Donor Services; NVLV – Nevada Donor Network; NYAP – Center for Donation and Transplant (Albany, NY); NYFL – Finger Lakes Donor Recovery Network (NY); NYRT – LiveOnNY (New York City); NYWN – ConnectLife (Buffalo, NY); OHLB – Lifebanc (Cleveland, OH); OHLC – Life Connection of Ohio (Dayton/Toledo, OH); OHLP – Lifeline of Ohio (Columbus, OH); OHOV – LifeCenter Organ Donor Network (Cincinnati, OH); OKOP – LifeShare of Oklahoma; ORUO – Cascade Life Alliance (Oregon); PADV – Gift of Life Donor Program (Philadelphia, PA); PATF – CORE, Center for Organ Recovery & Education (Pittsburgh, PA); PRLL – LifeLink of Puerto Rico; SCOP – We Are Sharing Hope SC (South Carolina); TNDS – Tennessee Donor Services; TNMS – Mid-South Transplant Foundation (Tennessee); TXGC – LifeGift (Houston, Lubbock, Fort Worth, TX); TXSA – Texas Organ Sharing Alliance (San Antonio, TX); TXSB – Southwest Transplant Alliance (Dallas, TX); UTOP – DonorConnect (Utah); VATB – LifeNet Health (Virginia Beach, VA); WALC – LifeCenter Northwest (WA, AK, MT, N. Idaho); WIDN – Versiti Wisconsin, Inc. (Milwaukee, WI); WIUW – UW Health Organ and Tissue Donation (Madison, WI).

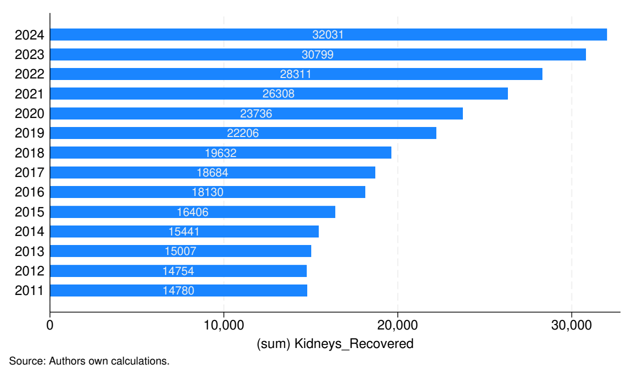
Figure 3: Annual Donors and Recovered Organs, 2011 to 2024



(a) Donors



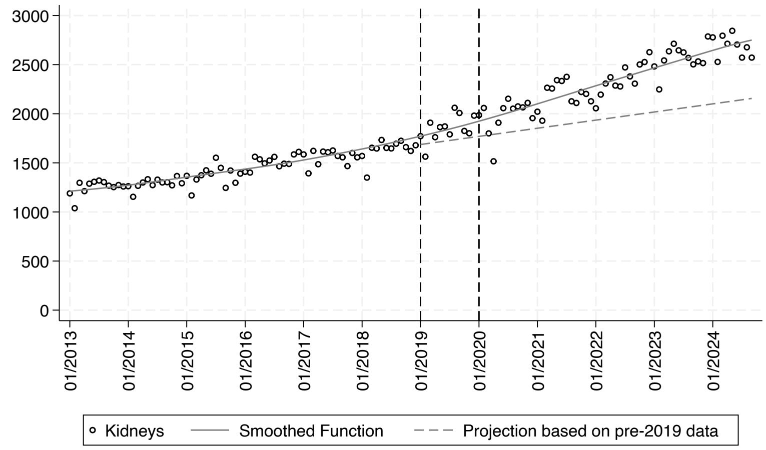
(b) All Organs



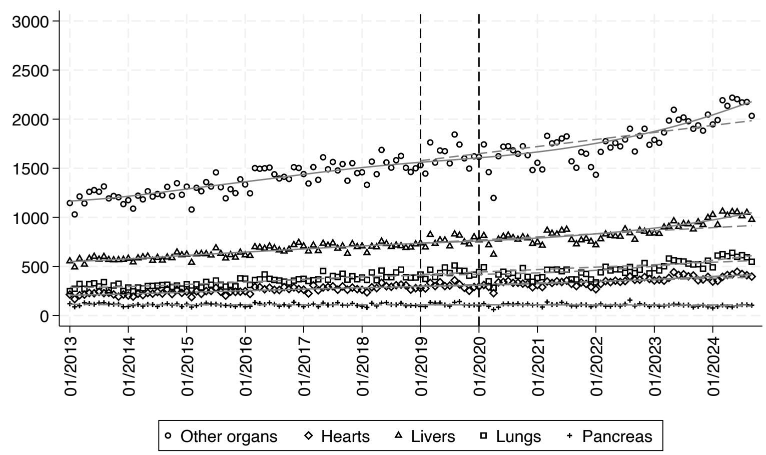
(c) Kidneys

Notes: Authors' calculations. Panel (a) displays the number of annual donors; panel (b), the number of annual recovered organs; and panel (c), the number of annual recovered kidneys. For 2024 we annualize the total number of donors, organs, and kidneys using information available up to September, the most recent month of data.

Figure 4: Monthly Recovered Organs, January 2013 to September 2024



(a) Kidneys

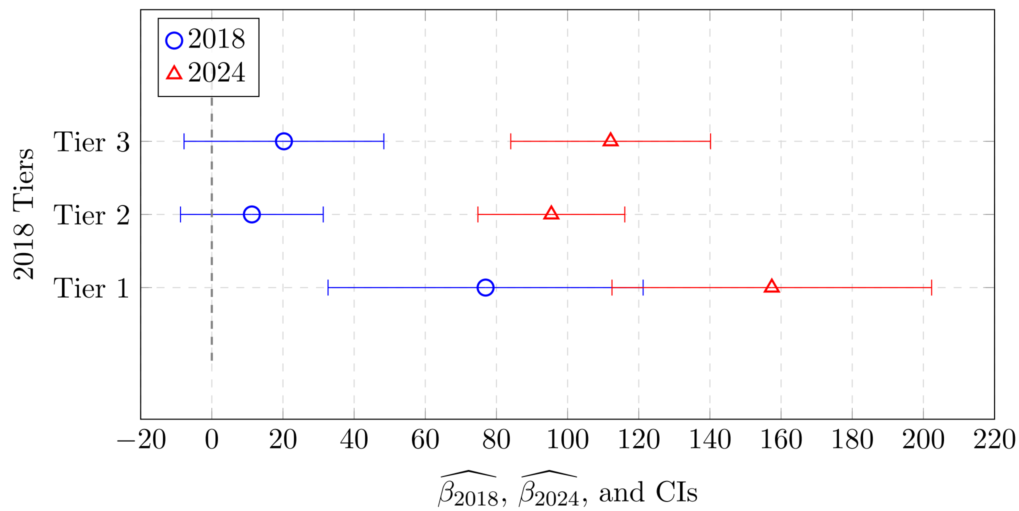


(b) Other organs

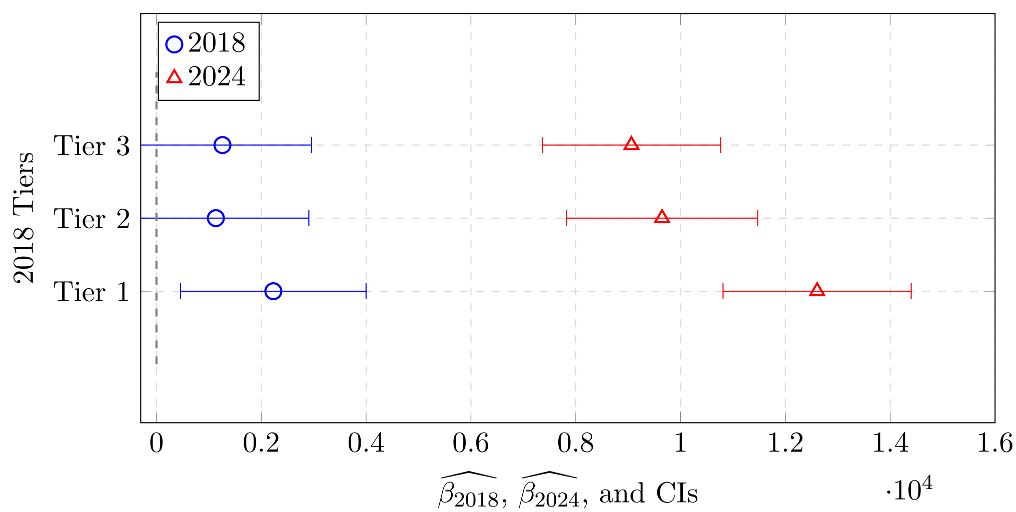
Notes: Authors' calculations. Panel (a) displays the series of total monthly kidneys recovered, including its nonparametric trend (solid line). It also shows a trend estimated using pre-reform data and extrapolated for the months following December 2019. Panel (b) presents the same analysis for all other organs, both combined and separately for hearts, livers, lungs, and pancreas.

Figure 5: Increases in Total Personnel and Procurement Coordinator Costs: 2018 versus 2024 (both relative 2015) by Tiers

(a) Full-time Employees



(b) Procurement Coordinator Costs

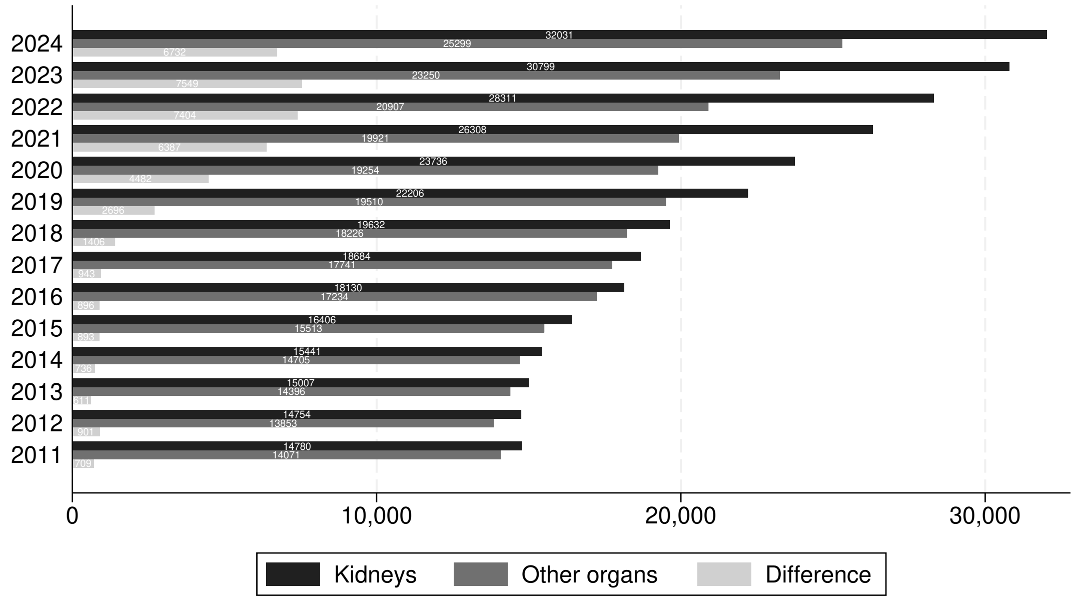


Note: The table reports the estimated values for β_{2018} and β_{2024} and their associated confidence intervals from the regression:

$$y_{jt} = \alpha + \sum_{t=2016}^{2024} \beta_t D_t + \alpha_j + \mu_{jt},$$

where $\{D_t\}_{t=2016}^{2024}$ denotes a set of year indicators, and α_j represents OPO fixed effects. The year 2015 serves as the baseline. Panel (a) presents results for total full-time employees (TFE in Table 2), while panel (b) shows results for procurement coordinators costs (PCC in Table 2).

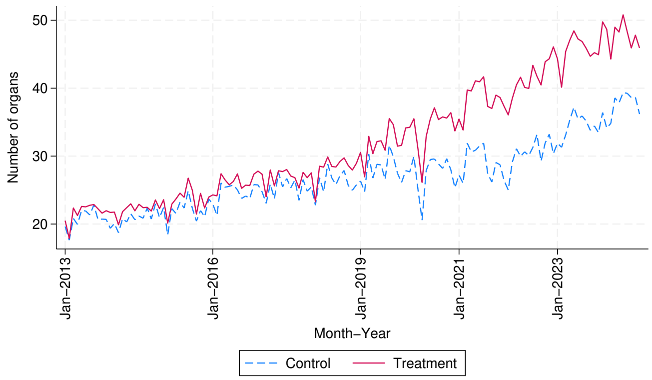
Figure 6: Annual Recovered Organs: Kidneys vs. Other Organs, 2011-2024



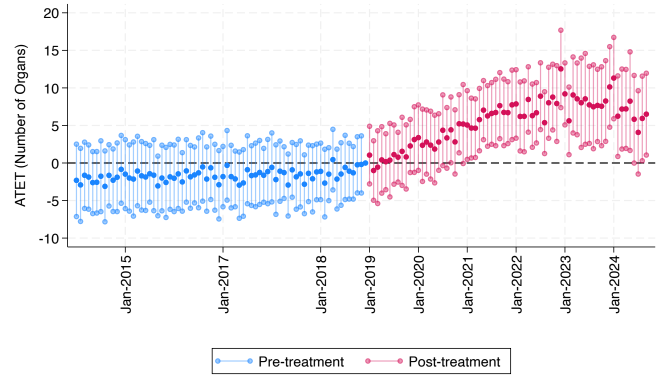
Source: Authors own calculations.

Note: The figure compares the annual number of recovered kidneys and other organs. Under "Difference," it also reports the gap between the two series. The evolution of this difference illustrates the core logic of our identification strategy. For 2024 we annualize the figures using information available up to September, the most recent month of data.

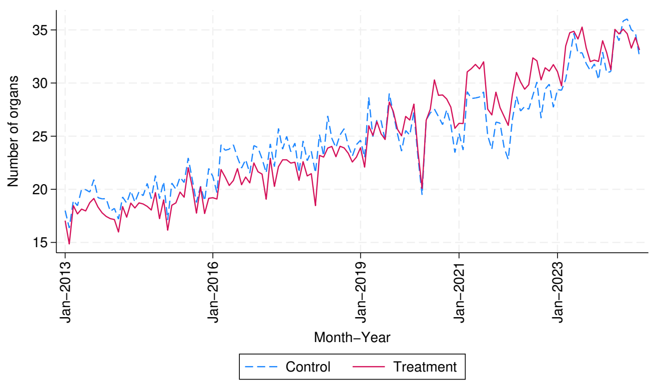
Figure 7: Average Monthly OPO-level Recovered and Transplanted Organs: Kidneys (Treatment) vs. Other Organs (Control)



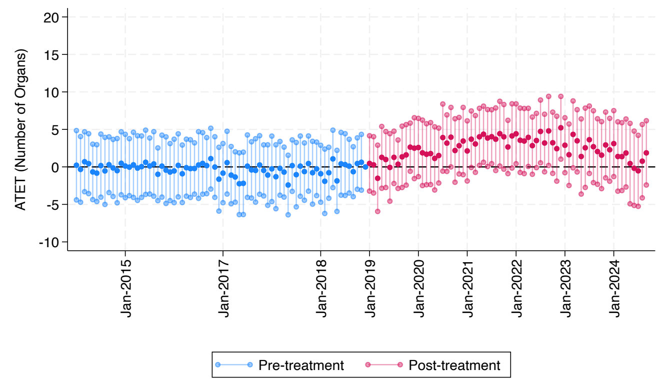
(a) Recovered - Trends



(b) Recovered - ATET



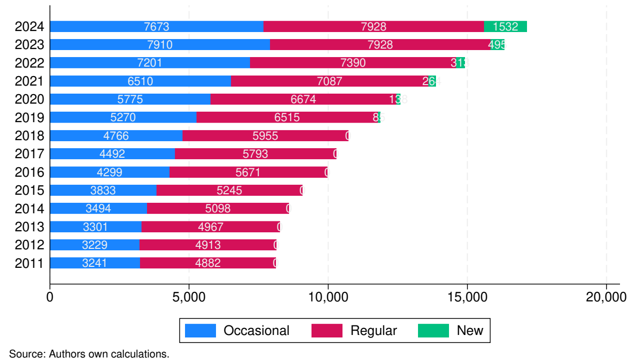
(c) Transplanted - Trends



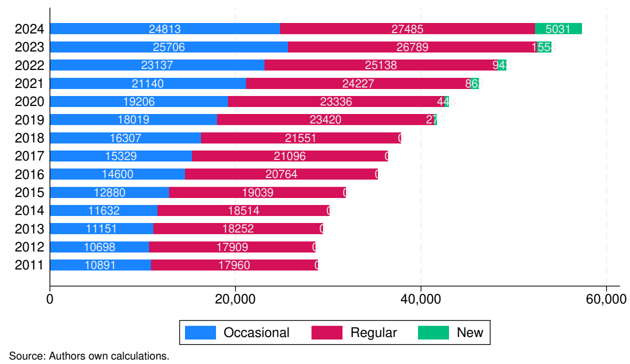
(d) Transplanted - ATET

Note: "Kidneys" represent the treatment group, while "Other Organs" serve as the control group. Panels (a) and (b) display the trends in the number of organs recovered for both groups and the estimated evolution of average treatment effects derived from the event-study plots, respectively. Panels (c) and (d) repeat the analysis for transplanted organs. The bands in panels (b) and (d) represent 95% confidence intervals.

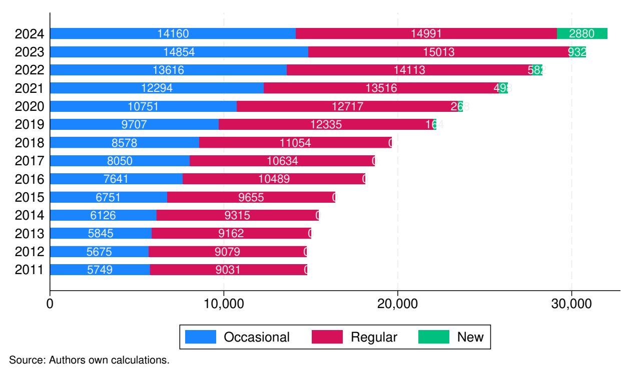
Figure 8: Total Donors, Organ Recoveries, and Kidney Recoveries by Hospital Type (2011-2024)



(a) Donors



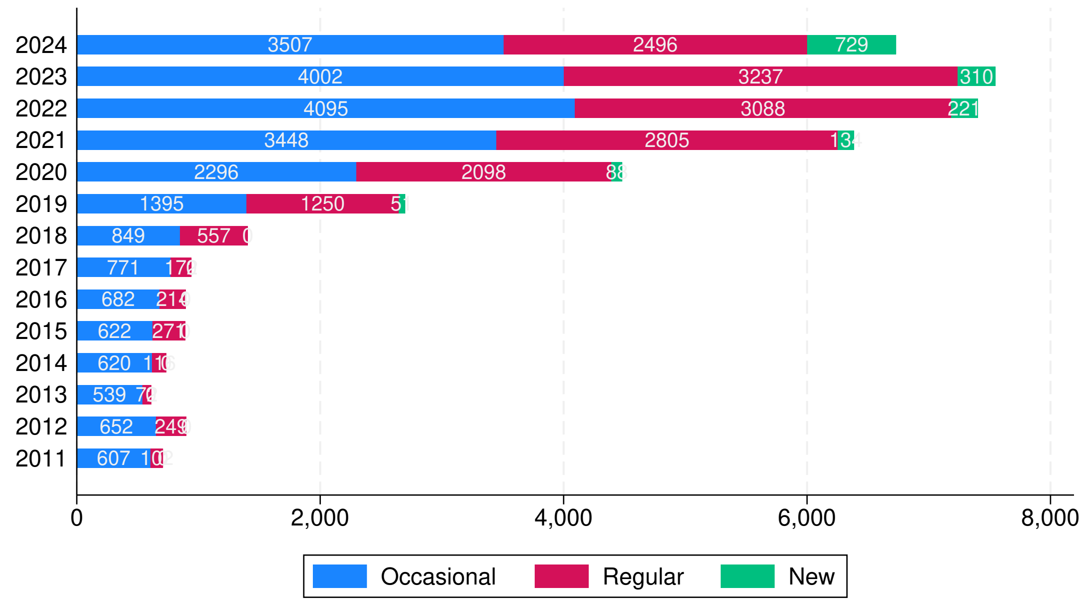
(b) All Organs



(c) Kidneys

Note: Panel (a) decomposes the annual number of donors from 2011 to 2024 across three types of hospitals. *New hospitals* are defined as institutions with which OPOs recorded their first interaction after January 2019. *Regular hospitals* are those that provided donors and organs in more than 50% of the months between January 2011 and December 2018, indicating sustained engagement prior to the reform. *Occasional hospitals* are those that did so in fewer than 50% of the months during the same pre-reform period. Panel (b) repeats the analysis for the annual series of all organs, while panel (c) does so for kidneys. For 2024 we annualize the figures using information available up to September, the most recent month of data.

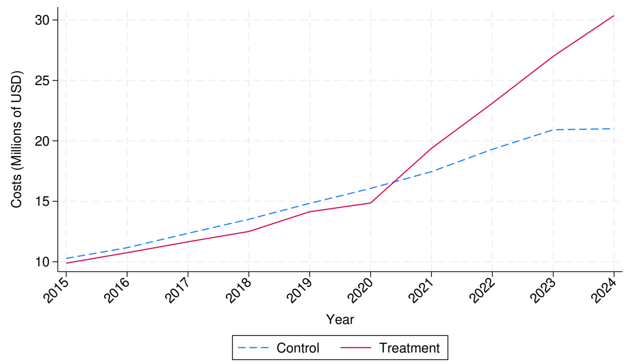
Figure 9: Difference in Kidneys vs. Other Organ Recoveries by Hospital Type, 2011–2024



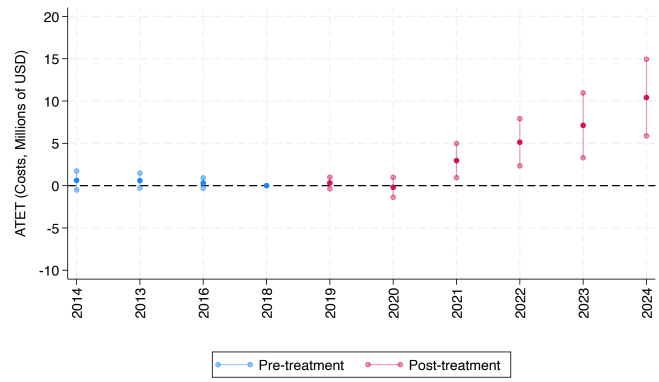
Source: Authors own calculations.

Note: The figure decomposes the difference between kidney recoveries (treatment group) and other organ recoveries (control group) from 2011 to 2024 across three types of hospitals. “Other organs” excludes kidneys. *New hospitals* are defined as institutions with which OPOs recorded their first interaction after January 2019. *Regular hospitals* are those that provided donors and organs in more than 50% of the months between January 2011 and December 2018, indicating sustained engagement prior to the reform. *Occasional hospitals* are those that did so in fewer than 50% of the months during the same pre-reform period. For 2024 we annualize the figures using information available up to September, the most recent month of data.

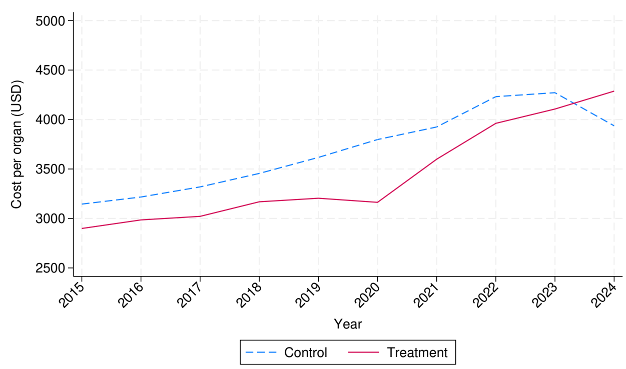
Figure 10: The Impact of the Reform on OPO-level Costs
Kidneys (Treatment) vs. Other Organs (Control), 2015-2024



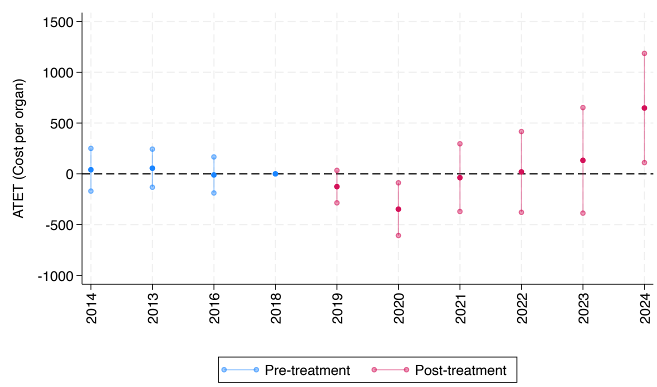
(a) Total - Trends



(b) Total - ATET



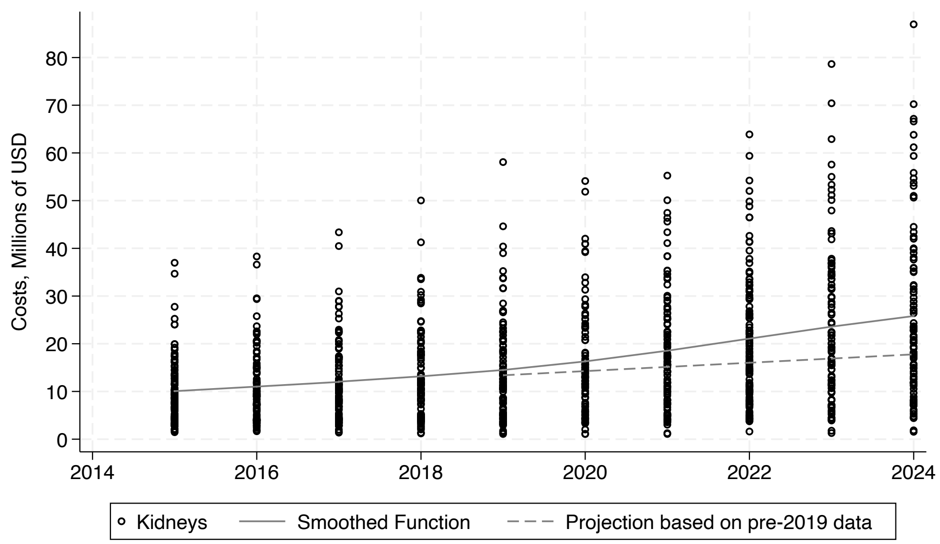
(c) Per organ - Trends



(d) Per organ - ATET

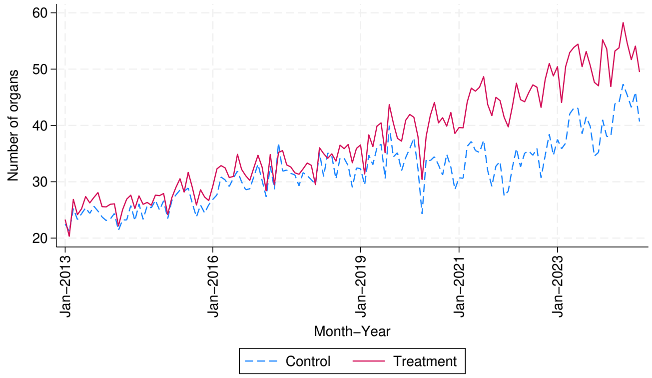
Note: "Kidneys" represent the treatment group, while "Other Organs" serve as the control group. Panel (a) shows the trends in OPO-level costs for both groups, and panel (b) presents the estimated evolution of average treatment effects derived from the event-study analysis. Panels (c) and (d) repeat the analysis for per-organ costs. The shaded bands in panels (b) and (d) represent 95% confidence intervals. "Other Organs" include hearts, lungs, pancreas, and livers. "For panels (c) and (d), we annualize the 2024 number of organs using data available through September, the most recent month reported.

Figure 11: Annual OPO-level costs associated with kidney procurement, 2015-2024

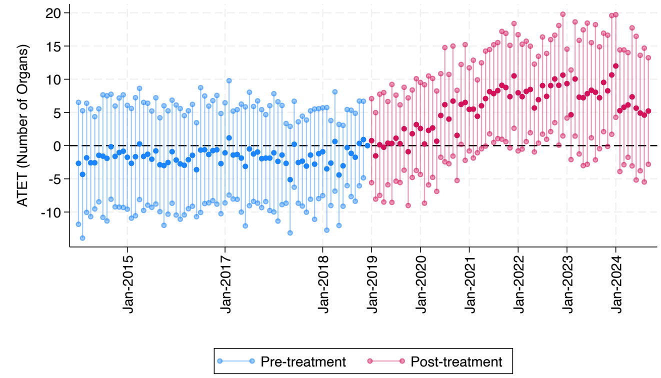


Notes: The figure displays OPO-level costs associated with kidney procurement, including a nonparametric trend (solid line). It also includes a linear trend estimated using pre-reform data and extrapolated into the post-reform period (dashed line). For 2024 we annualize the figures using information available up to September, the most recent month of data.

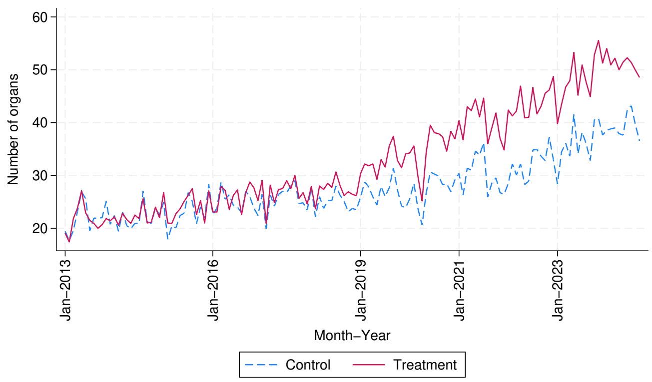
Figure 12: The Impact of the Reform on Monthly OPO-level Recovered Organs: Kidneys (Treatment) vs. Other Organs (Control) by tier (2011-2024)



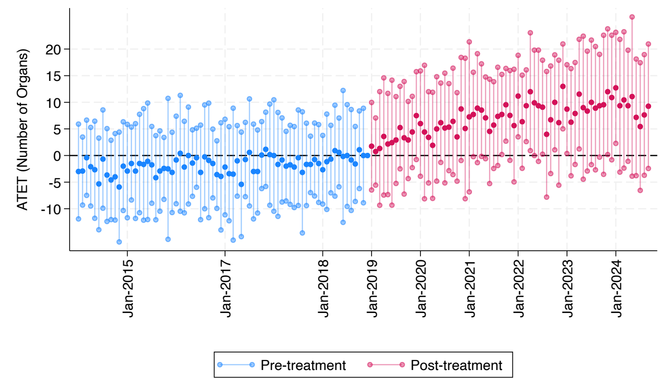
(a) Tier 1 - Trends



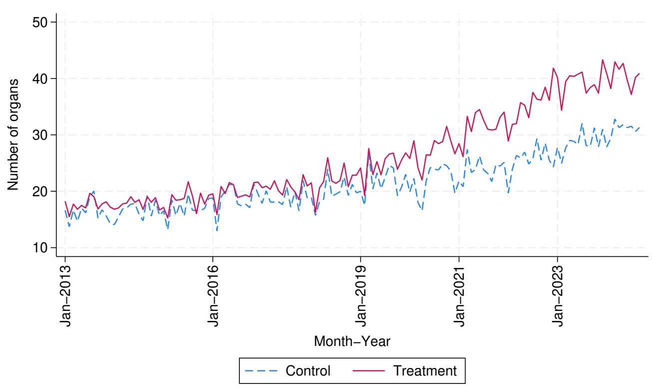
(b) Tier 1 - ATET



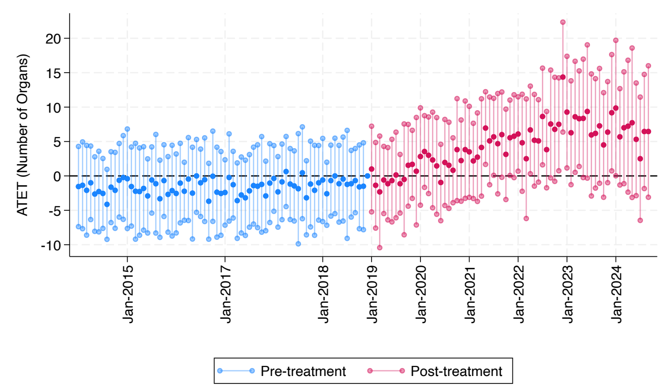
(c) Tier 2 - Trends



(d) Tier 2 - ATET



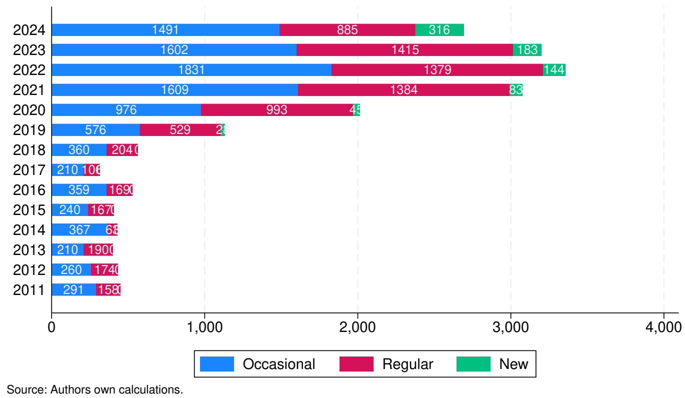
(e) Tier 3 - Trends



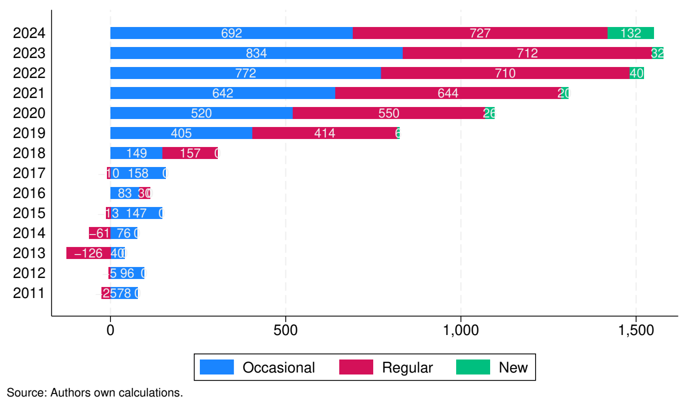
(f) Tier 3 - ATET

Note: "Kidneys" represent the treatment group, while "Other Organs" serve as the control group. For Tier 1 OPOs, panels (a) and (b) display the trends in the number of organs recovered for both groups and the estimated evolution of average treatment effects derived from the event-study analysis, respectively. Panels (c) and (d) and panels (e) and (f) repeat the analysis for Tiers 2 and 3, respectively. The shaded bands in panels (b), (d), and (f) represent 95% confidence intervals.

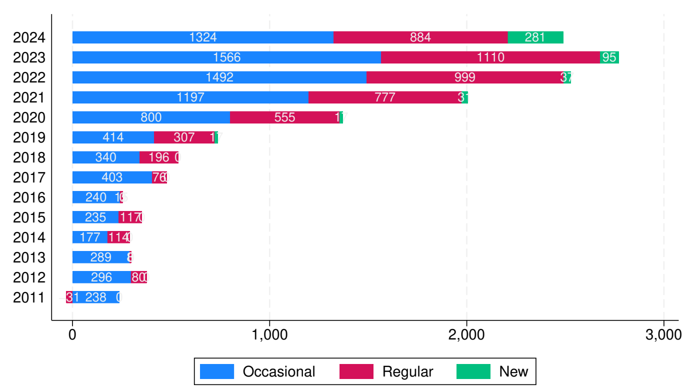
Figure 13: Difference in Kidneys vs. Other Organ Recoveries by Hospital Type and Tier (2011-2024)



(a) Tier 1



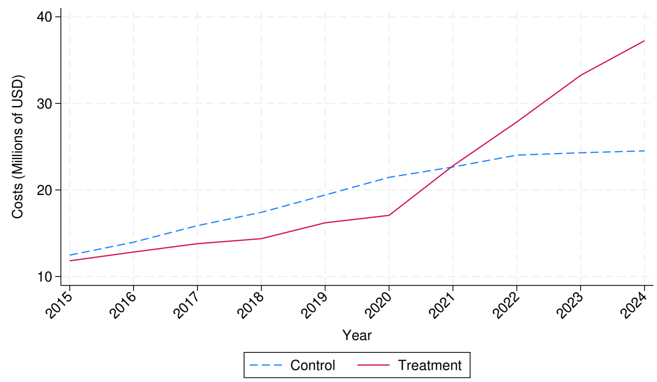
(b) Tier 2



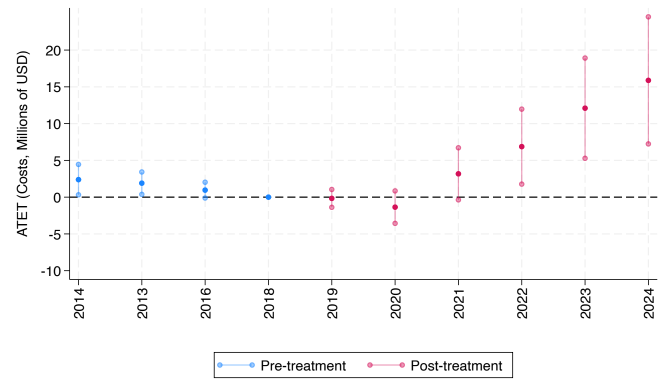
(c) Tier 3

Note: For Tier 1 OPOs, panel (a) decomposes the difference between kidney recoveries (treatment group) and other organ recoveries (control group) from 2011 to 2024 across three types of hospitals. "Other organs" excludes kidneys. Panels (b) and (c) repeat the analysis for Tiers 2 and 3, respectively. *New hospitals* are defined as institutions with which OPOs recorded their first interaction after January 2019. *Regular hospitals* are those that provided donors and organs in more than 50% of the months between January 2011 and December 2018, indicating sustained engagement prior to the reform. *Occasional hospitals* are those that did so in fewer than 50% of the months during the same pre-reform period. For 2024 we annualize the figures using information available up to September, the most recent month of data.

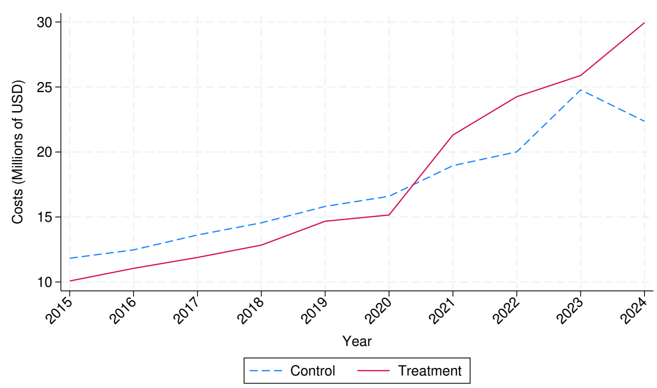
Figure 14: The Impact of the Reform on OPO-level Costs: Kidneys (Treatment) vs. Other Organs (Control) by tier (2015-2024)



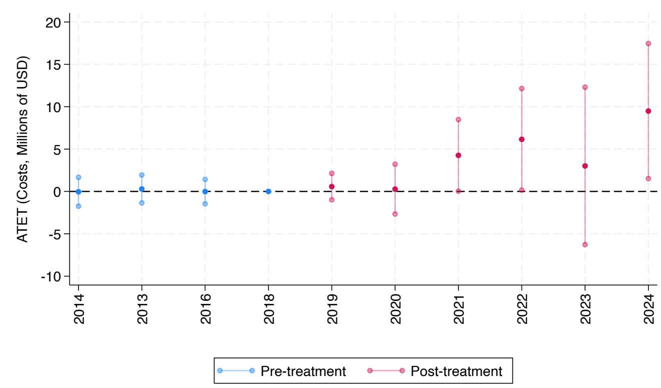
(a) Tier 1 - Trends



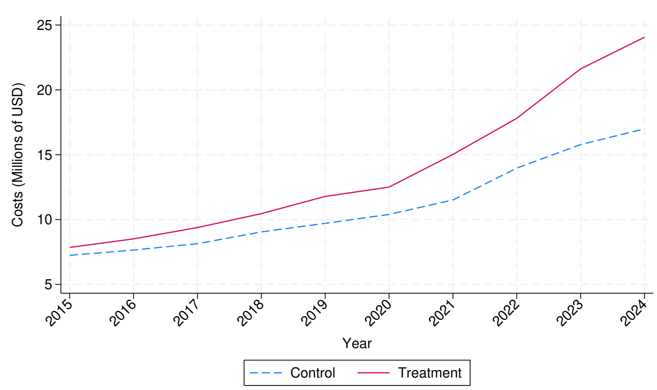
(b) Tier 1 - ATET



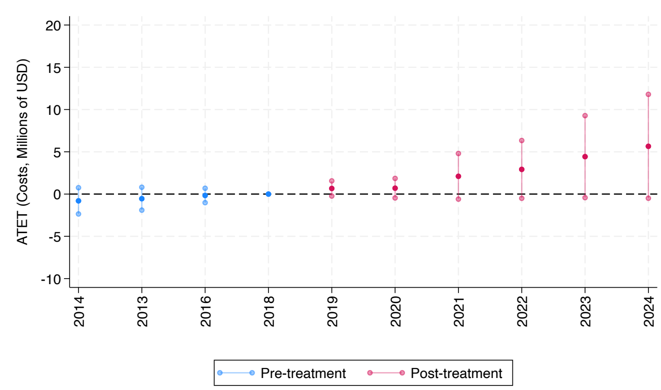
(c) Tier 2 - Trends



(d) Tier 2 - ATET



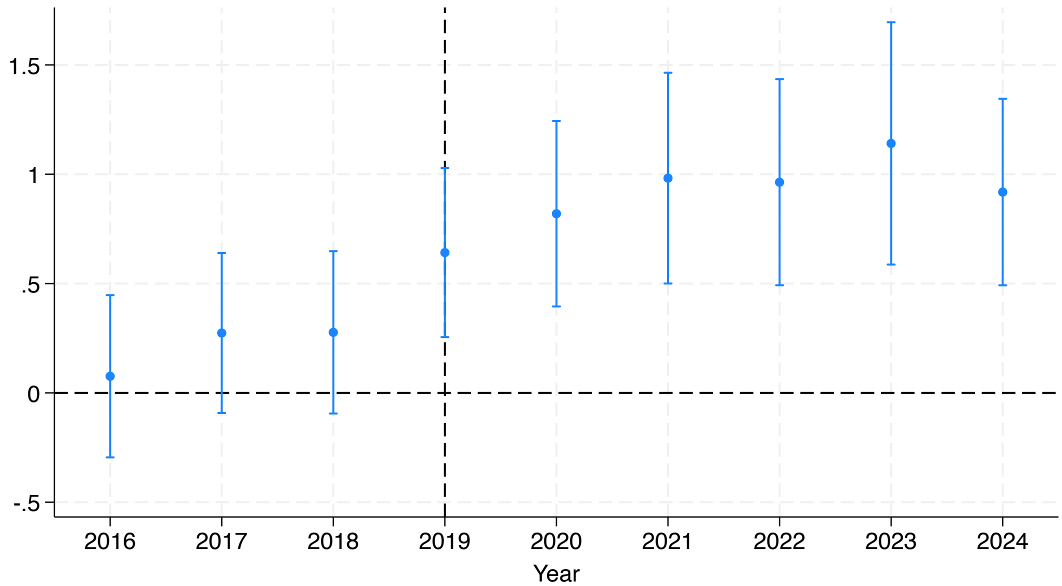
(e) Tier 3 - Trends



(f) Tier 3 - ATET

"Kidneys" represent the treatment group, while "Other Organs" serve as the control group. For Tier 1 OPOs, panels (a) and (b) show the trends in OPO-level costs for both groups and the estimated evolution of average treatment effects derived from the event-study analysis, respectively. Panels (c) and (d) repeat the analysis for Tier 2, and panels (e) and (f) for Tier 3. The shaded bands in panels (b), (d), and (f) represent 95% confidence intervals.

Figure 15: Reform-Induced Diseconomies of Scope among Tier 2 OPOs

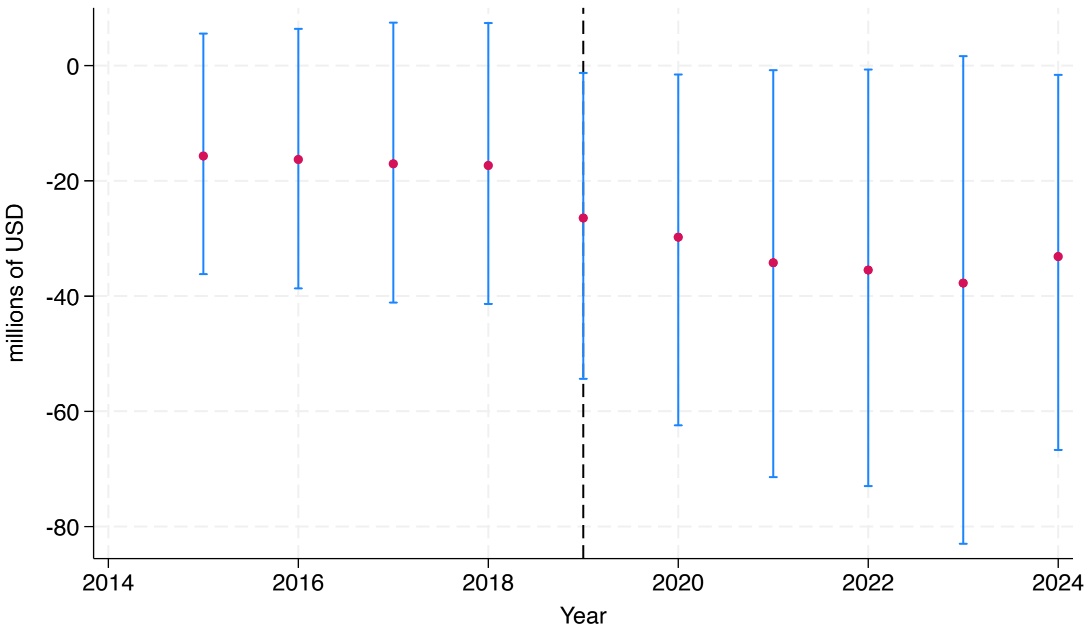


Note: The figure reports the year-specific estimated coefficients and associated confidence intervals for the $q_1 \times q_2$ interaction from the regression with year indicators ($\mathbf{1}[t = \tau]$) estimated using the sample of Tier 2 OPOs:

$$C_{it}(q_1, q_2; \mathbf{w}) = \alpha_0 + \alpha_1 q_{1,i,t} + \alpha_2 q_{2,i,t} + \alpha_3 D_t + \alpha_{12} q_{1,i,t} q_{2,i,t} + \sum_{\tau=2016}^{2024} \delta_\tau \mathbf{1}[t = \tau] q_{1,i,t} q_{2,i,t} + \tau_t + \gamma_i + \epsilon_{i,t},$$

where τ_t and γ_i denote the time and OPO fixed-effects.

Figure 16: Specialization Incentives after the Reform: Average Best_{it} in year t across OPOs



Note: The figure reports the average specialization incentives,

$$\text{Best}_{it} \equiv \min\{\text{penK}_{it}, \text{penO}_{it}\},$$

and presents uncertainty bands corresponding to the 10th and 90th percentiles of the mean's bootstrap distribution, based on 500 OPO-clustered replications.

A Other Results

Table A1: The Evolution of Average Monthly Donors: Yearly trend, 2011-2024 (2011 as baseline)

VARIABLES	(1) Tier 1	(2) Tier 2	(3) Tier 3	(4) Overall
2012	-0.017	0.201	-0.061	0.010
	(0.436)	(0.537)	(0.401)	(0.262)
2013	0.640	-0.176	-0.108	0.188
	(0.436)	(0.539)	(0.401)	(0.262)
2014	1.199***	0.306	0.232	0.649**
	(0.436)	(0.537)	(0.400)	(0.262)
2015	2.226***	1.153**	0.489	1.347***
	(0.436)	(0.537)	(0.400)	(0.262)
2016	4.265***	2.125***	1.132***	2.637***
	(0.436)	(0.537)	(0.401)	(0.262)
2017	4.581***	2.583***	1.713***	3.082***
	(0.436)	(0.537)	(0.400)	(0.262)
2018	5.574***	2.592***	2.285***	3.713***
	(0.436)	(0.538)	(0.400)	(0.262)
2019	7.094***	4.956***	3.698***	5.366***
	(0.436)	(0.538)	(0.400)	(0.262)
2020	7.768***	6.382***	4.883***	6.389***
	(0.436)	(0.537)	(0.400)	(0.262)
2021	9.740***	8.170***	7.057***	8.398***
	(0.436)	(0.550)	(0.400)	(0.263)
2022	10.719***	9.836***	9.107***	9.923***
	(0.436)	(0.550)	(0.400)	(0.263)
2023	13.284***	12.351***	11.391***	12.371***
	(0.441)	(0.550)	(0.400)	(0.264)
2024	14.495***	13.960***	12.352***	13.562***
	(0.477)	(0.596)	(0.432)	(0.286)
Observations	3,937	1,929	3,620	9,486
R-squared	0.821	0.814	0.823	0.827
OPO FE	YES	YES	YES	YES
Average Y (t=0)	15.74	13.33	10.30	13.18

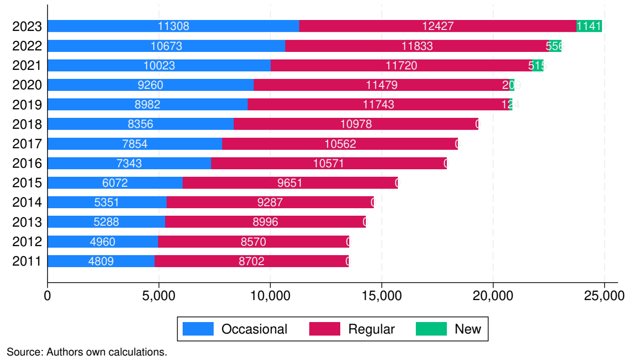
Note: The table displays the evolution of average monthly donors per year using 2011 as the baseline. Columns (1)-(3) report the results by tiers, while column (4) reports the overall estimates. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A2: Heterogeneous Effects by Tier
The impact of the reform on OPO-level costs per organ

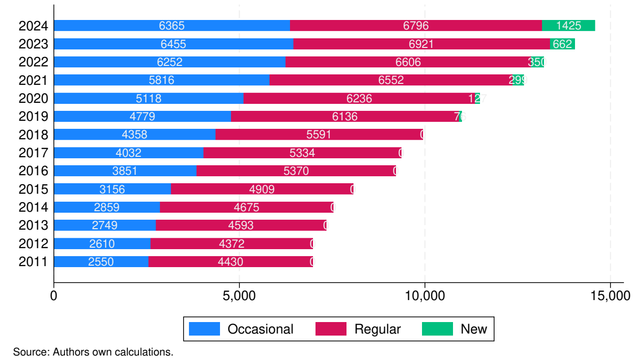
Tiers:	Tier 1 (1)	Tier 2 (2)	Tier 3 (3)
	A. Full sample		
DiD	-44.98	123.1	34.94
	(209.5)	(352.4)	(171.2)
H_0 : Parallel Trend (p-value)	0.0067	0.325	0.520
Observations	396	212	399
	B. Excluding 2019		
DiD	17.48	172.1	35.35
	(239.8)	(407.6)	(200.3)
H_0 : Parallel Trend (p-value)	0.0067	0.325	0.520
Observations	356	190	359
	C. Excluding 2020		
DiD	85.22	208.4	68.03
	(228.3)	(363.8)	(192.9)
H_0 : Parallel Trend (p-value)	0.0067	0.325	0.520
Observations	356	190	359
	D. Excluding 2019 and 2020		
DiD	196.9	302.3	76.77
	(275.6)	(407.6)	(235.4)
H_0 : Parallel Trend (p-value)	0.0067	0.363	0.520
Observations	316	168	319
$\bar{Y}$: Control group in pretreatment period	3,362	3,474	3,100
$\bar{Y}$: Treatment group in pretreatment period	2,787	3,267	3,113

Notes: The table reports the estimated coefficient β from equation (1), using annual information on procurement costs per organ at the OPO level, disaggregated by Tier, across different samples. Panel (a) reports results for the full sample; panel (b) excludes data from 2019, and panel (c) excludes 2018. "Kidneys" constitute the treatment group, while "Other Organs" serve as the control group. The treatment period begins in January 2019. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

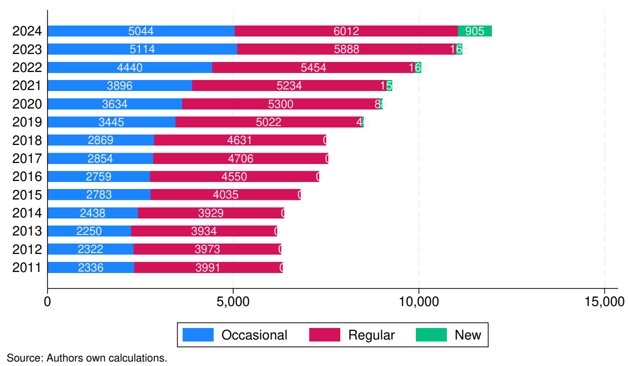
Figure A1: All Organs and Kidneys recovered by hospital type and tier, 2011 to 2024



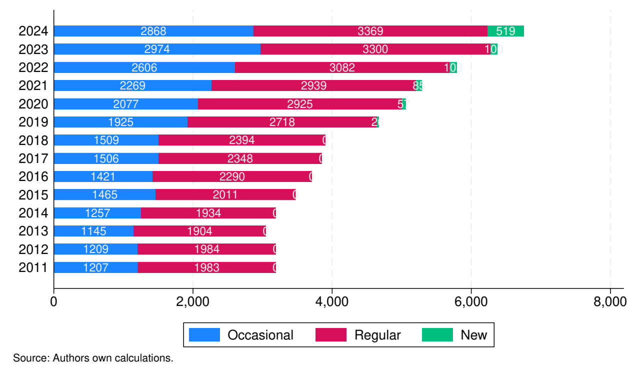
(a) **Tier 1: All organs**



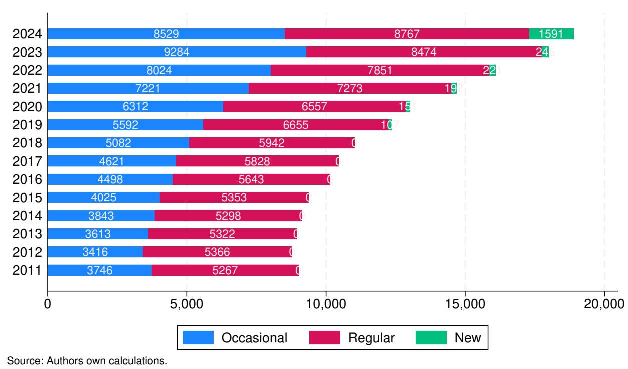
(b) **Tier 1: Kidneys**



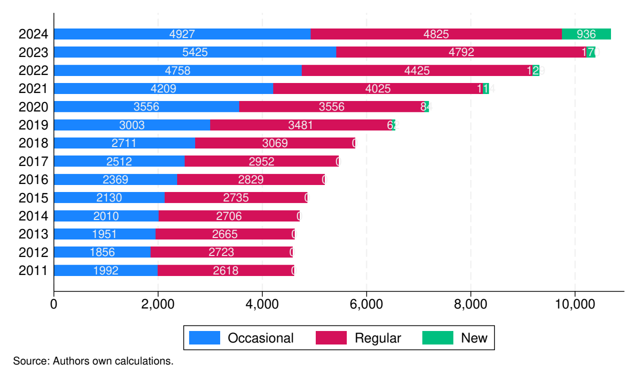
(c) **Tier 2: All organs**



(d) **Tier 2: Kidneys**



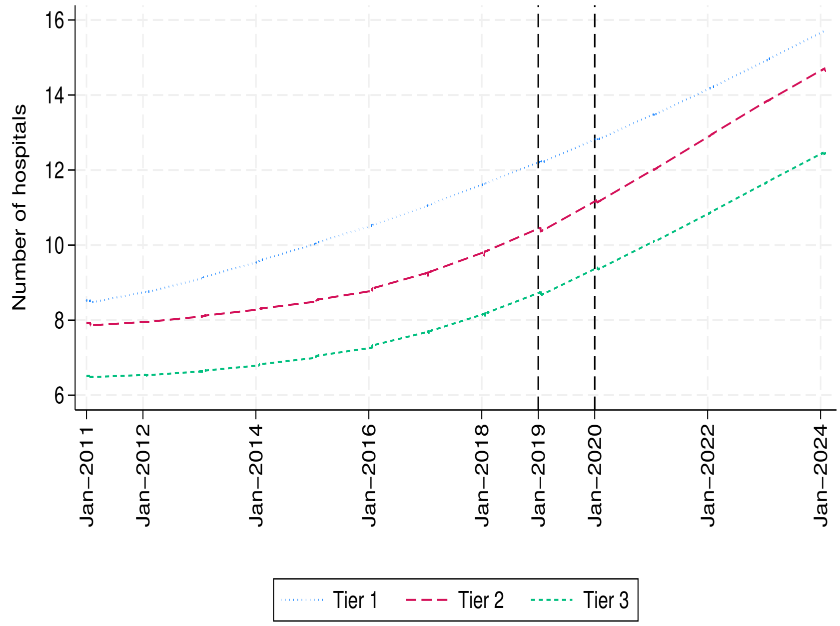
(e) **Tier 3: All organs**



(f) **Tier 3: Kidneys**

Note: The figures decompose the sources of organs across three types of hospitals. *New hospitals* are defined as institutions with which OPOs recorded their first interaction after January 2019. *Regular hospitals* are those that provided donors and organs in more than 50% of the months between January 2011 and December 2018, indicating sustained engagement prior to the reform. *Occasional hospitals* are those that did so in fewer than 50% of the months during the same pre-reform period. For 2024 we annualize the figures using information available up to September, the most recent month of data.

Figure A2: Number of Hospitals by Tier, 2011-2024



Note: The figure displays the evolution of the average number of hospitals the OPOs had contact with on a monthly basis between January 2011 and January 2024 by tier.