Lost in Transplantation:
Cost Shifting in Publicly Subsidized Programs

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Abstract

This paper investigates whether publicly funded programs allocate resources toward overhead expenses exceeding permissible limits, potentially undermining their core missions. Specifically, we examine this issue within the U.S. organ procurement market, where Medicare's transplant reimbursement system may inadvertently incentivize organ procurement organizations (OPOs) to disproportionately allocate funding to Kidney's overhead rather than other organs. Utilizing comprehensive financial data from 51 independent OPOs covering the period from 2015 to 2021, we explore cost allocation behaviors across the four most demanded organs—kidneys, livers, hearts, and lungs. We apply variance decomposition and Oaxaca–Blinder decomposition techniques to identify patterns of cost-shifting influenced by different reimbursement methods. Our findings reveal significant unexplained overhead variances associated with kidney procurements, indicating strategic cost-shifting from other organs to maximize Medicare reimbursements. The analysis demonstrates that overhead expenses contribute substantially more to the variation in kidney procurement costs compared to other organs, highlighting potential inefficiencies and regulatory vulnerabilities within the current system. These results underscore the need for greater financial transparency and more rigorous oversight within publicly funded healthcare programs. Our study contributes methodologically and empirically to healthcare economics literature, providing valuable insights for policymakers seeking to enhance efficiency, accountability, and equity in resource allocation within the vital U.S. organ transplantation system.

1 Introduction

This paper examines whether publicly funded programs allocate resources toward overhead costs that exceed allowable limits, potentially undermining their core missions. These concerns have attracted heightened public scrutiny, as illustrated by the second Trump administration's decision to limit the allocation of overhead costs in National Institutes of Health grants.[1] This issue is especially significant in the U.S. organ procurement market, where Medicare's transplant reimbursement program—originally designed to support the recovery of donor organs—creates incentives for stakeholders to allocate unlimited subsidized funds toward overhead expenses rather than toward direct costs for organ retrieval activities (Held et al. 2020; Rosenberg et al. 2020; Bragg-Gresham et al. 2024).

The U.S. organ transplantation system relies on 57 OPOs[2], including 51 independent, private non-profits and six hospital-based organization. These OPOs operate under the Centers for Medicare & Medicaid Services (CMS) and are governed by the National Organ Transplant Act (NOTA) of 1984, which grants each OPO exclusive rights to recover deceased donor organs within its designated service area (DSA) and significant control over organ cost rates.[3] Under federal contract, the OPOs' goal is to supply all deceased donor organs to the nation's 287 transplant centers, serving patients on the national waiting list. Currently, this waitlist exceeds 107,000 people, with approximately 150 added daily and 7,500 dying annually (DeRoos et al., 2021).[4] The wait list is expected to expand further in the coming years as the demand for organ transplants continues to rise significantly (Spardy et al., 2023).

Recent congressional investigations led by the House Oversight Committee[5] and the Senate Finance Committee[6,7] have scrutinized the performance, finances, and potential conflicts of interest within the organ procurement industry. Additionally, the Office of Inspector General (OIG)

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[1] See NIH notice NOT-OD-25-068 and 'Self-inflicted wound': Widespread alarm as Trump administration slashes NIH funding | Higher Ed Dive

[2] Prior to Dec 31, 2020, there were 58 OPOs. As of January 1, 2021, two OPOs—LifeChoice Sonor Service and New England Donor Bank—merged, reducing the number to 57.

[3] See Centers for Medicare & Medicaid Services Medicare Provider Reimbursement Manual, Part 1 – Chapter 31.

[4] See Health and Human Services Administration for update statistics: National Transplant Waiting List Statistics.

[5] See House Committee on Oversight and Reform December 23, 2020.

[6] See The United States Senate Committee on Finance February 12, 2020.

[7] See 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.

at the Department of Health and Human Services (HHS) examined the cost allocations, uncovering that unallowable reimbursements for overhead costs that failed to meet Medicare requirements.[8] These findings suggest that taxpayer funds are being diverted to overhead expenses beyond allowable limits, raising serious concerns about wasteful resource allocation within a system designed to save lives. The pattern of public funded subsidies covering these excessive overhead expenses highlights a broader issue: publicly funded programs often shift and inflate costs, rather than strictly adhering to their core missions. In addition, recent theoretical paper by Chan and Roth (2024) conducted a laboratory experiment demonstrating that existing regulations governing transplant centers and organ procurement organizations create unintended incentives, which inefficiently reduce both organ recovery and successful transplantations. Concerns about financial transparency and regulatory oversight motivate our study, which explores the incentives driving asymmetric cost behavior within the nonprofit U.S. organ transplantation system and explores the subsequent financial and policy implications.

We approach our research question by studying cost allocation across the four most in-demand organs—kidneys, livers, hearts, and lungs—and propose an empirical framework to understand cost distribution in a setting where profit is not the primary objective, multiple reimbursement methods exist, and funding is derived from both commercial and public sources (i.e. private insurance and Medicare). Specifically, Medicare, the largest public insurer in the world, fully reimburses kidney retrieval and transplantation costs, while other organs, like livers, hearts, and lungs, are reimbursed through real-time negotiated prices with transplant centers and private insurers (Held et al. 2016; 2021). This dual funding model creates an opportunity for cross-subsidization; since kidney procurement expenses are fully covered by the federal program, OPOs may have a financial motive to allocate maximum costs toward kidney procurement. Using hand collected dataset from the annual cost reports of 51 independent OPOs from 2015 to 2021, obtained under the Freedom of Information Act (FOIA) and supplemented with data from CMS and other sources, we conduct a thorough analysis of organ costs allocation.

We first detail both direct and overhead organ acquisition charges, totaling $9.25 billion during our sample period. Employing variance decomposition models from labor economics and trade (Eaton et al., 2004; Hottman et al., 2016), along with Oaxaca–Blinder decomposition (Kitagawa, 1955; Blinder, 1973; Oaxaca, 1973), we analyze cost variations across OPOs, organs,

[8] See Office of Inspector General Report A-09-21-03020.

and reimbursement methods. Our goal is to understand the alternative reimbursement strategies and potential cost-shifting mechanisms that could impact the organ procurement process. This, in turn, may allow for a better understanding of alternative methods to increase reimbursement and revenue in the subsided markets —such as possible cost-shifting mechanisms—and thereby aid practitioners and policymakers enhance the oversight process. Using comprehensive cost reports of the entire independent OPO population, we are able to allocate organ acquisition overhead costs precisely as OPOs do and determine the average cost component for each procured organ. This approach allows us to investigate whether OPOs are inclined to shift organ acquisition overhead costs between different reimbursement programs and estimate the dollar value of such behavior.

First, using the variable decomposition analysis, we find that the unexplained *residual* in kidney standard acquisition charge (SAC) is at least 50% higher than for other organs, raising concerns about inefficiencies and possible opportunistic cost allocation due to varying reimbursement mechanisms. Furthermore, we find that direct costs account for over 70% in liver, heart, and lung total costs, while they represent only 30% in kidneys. In contrast, overhead costs contribute twice as much to kidney's SAC variation compared to other organs (30% vs. 15%). These disparities indicate that OPOs may not fully adhere to federal regulations requiring proportional cost allocation and may be using alternative strategies to increase reimbursement. Factors like organ volume, non-viable organ rates, and tissue sales revenue show little influence on cost variation, further supporting the likelihood that OPOs shift expenses from other organs to kidneys, potentially violating CMS regulations.

We subsequently quantify the dollar difference between high-cost and low-cost OPOs to understand the potential extent and magnitude of cost-shifting. Using the Blinder–Oaxaca decomposition, we quantify cost differences between high- and low-cost OPOs, revealing that the gap is smallest for kidneys ($8,586) and largest for lungs ($20,407). Notably, less than half of the kidney cost gap is explained by known factors—the lowest explained proportion among all organ types— while direct costs contribute far less than in other organs. Overhead costs, however, account for at least three times more of the kidney cost gap than in other organs, suggesting potential cost-shifting. These findings highlight systemic inefficiencies that could inflate costs and strain Medicare's stability.

This study makes several important contributions to the accounting and healthcare economics literature. First, this paper enhances the accounting literature by introducing a methodology specifically augmented to analyze overhead and direct cost allocations within publicly funded programs. Utilizing an empirical approach labor economics and trade (Eaton et al., 2004; Hottman et al., 2016), we identify instances where resource allocations toward overhead expenditures surpass established allowable limits, thereby strengthening oversight, transparency, and accountability in organizational cost management practices. Furthermore, by adapting the Oaxaca–Blinder decomposition—traditionally employed in labor economics to assess wage differentials—to the setting of non-profit organizations, we present an innovative analytical framework that effectively clarifies complex cost structures and quantifies inefficiencies and cross-subsidization in organizational finances. In doing so, our work extends established ratio- and regression-based methods in healthcare accounting research by offering new insights into how overhead and direct expenses can be strategically allocated, while also underscoring broader implications for organizational efficiency and accountability (Eldenburg and Soderstrom, 1996; Eldenburg and Kallapur, 1997; Eldenburg et al., 2011; Eldenburg et al., 2017). By adapting decomposition techniques to allocate resources and assign monetary values to different cost components, we build upon this existing literature and illustrate new avenues for examining cost allocation in non-profit healthcare settings. Although demonstrated within a non-profit healthcare context, our methodological approach is versatile and broadly applicable, serving as a robust blueprint for researchers examining the allocation of public subsidies or charitable funds across diverse mission-driven sectors, including education, social services, and healthcare. Furthermore, policymakers and regulators can leverage this framework as an effective accountability tool, helping to detect hidden financial imbalances and supporting evidence-based policy decisions that align resource allocation with intended organizational missions.

Second, our findings on varied cost patterns underscores the importance of greater transparency and a standardized approach to reimbursement and cost policy within OPOs to ensure operational efficiency. We demonstrate that different reimbursement methods, such as real-time pricing and end-of-year reconciliation can influence cost patterns, potentially resulting in expenses shifting from private insurers to Medicare (Eldenburg et al., 2017). Thus, we advance healthcare accounting research by clarifying the mechanisms and incentives driving cost-shifting behaviors. Previous studies (e.g., Eldenburg and Kallapur, 1997) have shown hospitals adjusting services to maximize revenue—a form of "real cost management," such as shifting patient services from inpatient to outpatient settings. Additionally, past research has indirectly documented “accrual cost management" through increased overhead allocations to outpatient services. We extend this literature by providing direct empirical evidence of accounting cost-shifting within OPOs. Through a detailed analysis of cost components, we explicitly outline how OPOs transfer expenses onto kidney procurement operations. Moreover, by examining the role of end-of-year reconciliations, we clarify how accounting practices facilitate such cost-shifting, thus deepening the understanding of these underlying mechanisms.

Finally, our research also can contribute to informing public health policy decisions by highlighting important concerns regarding potential weaknesses in the CMS oversight of the U.S. organ procurement system, which may lead to wasted taxpayer dollars, increased costs, and further destabilization of Medicare. These concerns gained additional urgency following an August 2023 audit by the Office of Inspector General (OIG), titled "Medicare Paid Independent Organ Procurement Organizations Over Half a Million Dollars for Professional and Public Education Overhead Costs That Did Not Meet Medicare Requirements." The OIG report detailed specific instances where Medicare improperly reimbursed independent Organ Procurement Organizations (OPOs) for overhead costs related to professional and public education, raising concerns about compliance and accountability within the existing reimbursement system. This urgency was further underscored by the second Trump administration’s February 2025 decision to limit the allocation of overhead costs in National Institutes of Health grants. However, we advise policymakers to approach reforms cautiously. Given the delicacy and life-saving importance of the organ procurement network, abrupt policy changes—such as immediately ending Medicare's cost reimbursement guarantee for kidney procurement— could inadvertently destabilize OPO finances and operations, thereby compromising organ recovery efforts unless alternative support structures are gradually introduced.

The remainder of the paper is structured as follows. First, we describe the industry and develop our hypotheses. Next, we describe the sample and the OPOs’ main cost components. We then detail the methodology and provide the results. Finally, we offer concluding remarks.

2 Institutional Background

2.1 Role of OPOs

In the United States, 57 federally designated nonprofit OPOs function under the regulatory framework established by the National Organ Transplant Act of 1984. Bases on the legal framework, each OPO is assigned a specific geographic service area, granting it an exclusive monopoly on the recovery of deceased donor organs within its designated service area. OPOs are tasked with a comprehensive role that includes the evaluation of potential organ donors, obtaining consent from next of kin, and the surgical extraction, preservation, and transportation of organs to transplant centers. While these organizations manage the procurement process, the subsequent allocation of organs is conducted by the Organ Procurement Transplantation Network (OPTN) and the United Network for Organ Sharing (UNOS)[9], with final acceptance decisions resting with individual transplant centers (Held et al., 2020). This division of responsibilities has been widely discussed in the literature as a means to balance operational efficiency with clinical discretion (Siminoff et al., 2001).

The importance of organ transplants cannot be overstated, as they are lifesaving interventions for patients with organ failure. However, the demand for organs significantly exceeds the supply, resulting in extended wait times and leading to around 7,500 deaths annually among patients awaiting transplants (DeRoos et al., 2021). At the heart of this critical process are the OPOs, which are responsible for identifying potential deceased donors, receiving consent for donation, and coordinating the procurement and allocation of organs from deceased donors across the United States.

Financial operations within the OPO system also exhibit considerable complexity. OPOs largely determine their own reimbursement rates for transplanted organs. For kidney procurement, the CMS provides full reimbursement, while the reimbursement for other organs is negotiated directly between OPOs and transplant centers. These negotiated rates, reflective of SAC, capture the various expenses associated with organ recovery and preservation. The autonomy to set these rates has sparked debate regarding cost efficiency and transparency, particularly given the substantial role of CMS in covering OPO expenditures (Naylor et al., 2017; Held et al., 2021).

Despite the CMS's periodic reviews of OPO costs and the United States having the world's most extensive organ transplant program, there is a notable lack of analysis regarding the overall costs of organ procurement. Furthermore, there is a staggering shortage of research concerning the

[9] It is worth noting that UNOS holds the federal contract from OPTN.

cost and quality of procured solid organs such as the kidney, liver, heart, and lung. What little research has been done has focused on kidney procurement, while other solid organs, which comprise approximately 50% of the market in terms of both quantity and cost, remain underexplored (Held et al., 2020; 2021). This gap is especially surprising given that OPOs regularly submit their financial data to the CMS and that the CMS covers a significant portion of all OPO expenses (Held et al. 2021). The absence of OPO-related research raises concerns in light of the monopolistic power of OPOs, the allegations of insufficient oversight that have been raised during U.S. Senate hearings, and the OPOs' authority to set their own costs, all of which call the network's cost efficiency into question.

The potential for a comparison of costs across OPOs emerges from the National Organ Transplantation Act, which requires OPOs to employ a standardized approach in determining the SAC of each organ. These costs are tabulated using Form CMS 216-94, which we have accessed for the years 2015–2021 through a FOIA request. As every U.S. region is overseen by a specific OPO, diverse factors can influence the associated expenses. These variables include local labor rates, the number of potential and actual donors, the density of transplant hospitals within an OPO's designated area, and the fees levied by hospitals for maintaining the viability of donor organs, among others (Held et al., 2020; 2021). Armed with this data, our primary objective is to delve into the determinants of organ procurement costs. We aim to furnish practitioners and policymakers with tangible data and analytical tools, paving the way for an enhanced organ procurement system.

2.2 Cost Allocation

Over the past decade, a growing body of accounting literature has explored the incentives that shape managers' decisions regarding firms' cost structures (e.g., Chen et al., 2012; Dierynck et al., 2012; Kama and Weiss, 2013). This research emphasizes that cost structure decisions are not merely driven by operational constraints but are strategic choices influenced by managerial expectations, behavioral biases, and competitive dynamics.

Anderson et al. (2003) and Banker et al. (2014) explore cost stickiness —quickly raising expenses during sales growth and cutting them more slowly when sales decline— and demonstrate that managers adjust cost structures asymmetrically in response to changes in revenue and market conditions, rather than reacting solely to operational constraints. Subsequent research examines the intrinsic mechanisms of cost stickiness (Weiss, 2010; Hartlieb et al., 2020). Chen et al. (2012) document that managers with empire-building incentives tend to increase selling, general, and administrative (SG&A) expenses rapidly in response to rising sales, yet they reduce these costs much more slowly when sales decline. This behavior, which implies a positive relationship between agency problems and the degree of SG&A cost asymmetry, is supported by a broader literature that shows managers often reduce costs selectively to meet benchmarks and avoid earnings shortfalls (Baber et al., 1991; Dechow & Sloan, 1991; Bushee, 1998; Graham et al., 2005; Roychowdhury, 2006; Cohen et al., 2008). Building on an agency perspective, Chen et al. (2013) provide evidence that cost adjustments to revenue fluctuations are shaped not only by strategic considerations but also by behavioral factors such as managerial overconfidence in future demand growth. Calleja et al. (2006) examine European and American companies and find that cost structure and stickiness are influenced by corporate governance and management supervision systems.

In the healthcare industry, cost management is influenced by regulatory constraints, demand fluctuations, and the complex nature of service delivery. Research highlights the presence of cost stickiness in settings like physical therapy clinics and hospitals, where costs don't decline symmetrically with revenue reductions. Studies by Balakrishnan et al. (2004), Balakrishnan and Gruca (2008), and Holzhacker et al. (2015) highlight that healthcare institutions exhibit asymmetric cost behavior, with costs being more resistant to decline despite reduced patient volumes or revenue. This reflects the complexities of cost adjustment influenced by managerial discretion, regulatory compliance, and quality care standards. Beyond cost stickiness, research in healthcare accounting has also documented extensive cost-shifting practices, particularly in U.S. hospital care (e.g., Danzon, 1982; Eldenburg and Soderstrom, 1996). Studies of hospitals in California and Washington state indicate that hospitals strategically shift costs to maximize net cash flows (Danzon, 1982; Eldenburg and Kallapur, 1997). Because overhead costs are allocated to departments rather than directly to patients, hospitals have considerable discretion in their distribution, allowing for strategic reclassification to optimize reimbursement structures. Further studies demonstrate that under deregulation, both nonprofit and for-profit hospitals leverage accounting standards to shift costs between payers while attempting to stay within regulatory constraints (Dranove, 1988; Eldenburg and Soderstrom, 1996). Together, these findings suggest that cost allocation in healthcare is not purely an operational necessity but a strategic decision shaped by managerial accounting practices in hospitals, reimbursement incentives, regulatory oversight, and financial performance objectives.

Within the broader healthcare cost structure, cost reimbursement mechanisms play a critical role in shaping OPOs' cost allocation practices. Medicare, as the largest health insurer in the United States, provides full reimbursement for organ procurement costs, particularly for kidneys, given its financial stake in treating end-stage rental disease (ESRD) patients. Compared to alternatives such as maintenance dialysis and associated medications, kidney transplantation is both a life-saving procedure and a cost-effective intervention, generating an estimated economic benefit of approximately $1.1 million per transplant (Held et al. 2016; 2021). To facilitate organ procurement, Medicare guarantees that OPOs are fully reimbursed for kidney procurements, whether viable or non-viable. By eliminating financial deterrents, the reimbursement system aims to ensure that kidney procurement remains financially viable and incentivized. However, while Medicare's full reimbursement policy is intended to improve transplant rates, it also creates strong incentives and opportunities for inappropriate and unallowable overhead cost-shifting behaviors, particularly given the inherent challenges of cost allocation in multi-organ procurements. By contrast, other organs—such as livers, hearts, and lungs—are reimbursed at market-driven rates, negotiated with transplant centers.

A further complexity arises from OPOs' monopolistic structure and limited financial disclosure. Since transplant centers cannot source organs outside their designated OPOs, they have little bargaining power in SAC negotiations. This lack of transparency enables cost variability and inefficiencies, raising concerns about unchecked cost allocation practices.

2.3 Conceptual Framework and Hypothesis Development

These dynamics highlight how reimbursement mechanisms influence cost allocation decisions within OPOs, reinforcing cost-shifting behaviors observed in other healthcare settings (Danzon, 1982; Eldenburg and Soderstrom, 1996; Banker et al., 2014). Using the CMS cost reimbursement framework, we hypothesize that OPO incentives and constraints, together with the regulatory environment, affect managers' strategic decision related to cost structure and encourage and facilitate OPOs' cost-shifting from other solid organs to kidneys. Although the CMS's allocation guidelines state that the ratio of costs should be consistent across organs, the OPOs' cost reimbursement mechanism presents several opportunities for this cost-shifting. First, direct costs (e.g., surgeon fees, laboratory tests) lack transparency, particularly when multiple organs are procured at once. In these cases, OPOs have discretion in how they allocate these costs across organ types. This flexibility can create an incentive to declare an intent to procure kidneys—even when clinical evidence suggests a low likelihood of success—because it can lead to more favorable reimbursement outcomes. Second, overhead costs (e.g., public and professional education) are allocated based on the relative number of total organs an OPO has procured by the end of the year (both viable and non-viable). This structure may further motivate OPOs to maximize the reported intent to procure organs (and especially fully reimbursed kidneys), as a higher count can influence how overhead costs are distributed. Third, the different reimbursement policies by the public and private insurance provide incentives to allocate unallowable overhead costs that failed to meet Medicare requirements to the cost of kidneys as shows by the report of the OIG at the HHS. Taken together, we predict that OPOs' costs will differ based on reimbursement mechanisms, and we state the first hypothesis in the alternative form:

HYPOTHESIS 1 (H1): *OPOs' cost structure will differ based on reimbursement mechanisms.*

Prior research has examined the relationship between total cost and its components, as well as the explanatory power of various activity cost components (e.g., Miller and Vollman, 1985; Foster and Gupta, 1990; Banker et al., 1995). Managerial incentives, for instance, play a crucial role in hospital financial and operational decisions. In nonprofit hospitals, both CEO turnover and compensation have been linked to financial performance, indicating that similar pressures may exist in for-profit firms (Brickley and Van Horn, 2002). Furthermore, cost-shifting behavior by nonprofit hospitals may be influenced both by normative pressures from stakeholders emphasizing patient-related services over revenue maximization, and by regulative factors such as oversight (Krishnan and Yetman, 2011). Specifically, hospitals facing greater normative pressure to appear efficient tend to shift costs more, whereas those under stricter regulatory oversight shift costs less.[10] Based on the evidence in the healthcare accounting literature, and considering the increase pressure on OPOs to figure out how to improve their performance, we expect that some OPOs

[10] In the defense industry, however, the evidence regarding cost-shifting is mixed. While some studies reveal cost-shifting to pension cost reimbursement programs, others find no evidence of cost-shifting when analyzing the profitability of defense contractor cost reimbursement programs (Thomas and Tung, 1992; McGowan and Vendrzyk, 2002).

allocate more overhead resources towards improving their donation rates and ultimately influencing the price charged per organ. We predict that OPOs investing significant resources in organs procurement will have greater incentives and opportunities to shift costs in response to reimbursement mechanisms, thereby increasing revenue. Thus, we state the second hypothesis as follows:

HYPOTHESIS 2 (H2): *OPOs with high organ costs shift more overhead cost based on reimbursement mechanisms*.

3 Sample Selection and Data Descriptive

Our sample consists of 51 independent OPOs from 2015 to 2021. We manually collected over 12,000 pages of financial and operational information related to procurement activities from federally mandated reports (Form CMS 216-94) obtained through a FOIA request. These reports contain details on the OPOs' revenue, expenses, operations, and the total number of organs procured. The process began with converting the FOIA-obtained reports into a machine-readable format using the original software in which they were produced, purchased from Health Financial Services. To generate a usable data output, we manually re-entered each figure from the reports into the software. We then compared the sums on each page of every report against the FOIA version to ensure accurate transcription. Finally, a second individual conducted a random review of several pages from each report to verify the accuracy of our data.

For each OPO, we further supplement this data with specific geographic data on population and the OPO coverage area (Scientific Registry of Transplant Recipients); information on the number of hospitals, donation centers, and donor-specific data (Organ Procurement and Transplantation Network); wage index data (Centers for Medicare & Medicaid Services); and CEO salary data from IRS Form 990, in cases where the salary data is missing from the FOIA-obtained forms (Return of Organization Exempt from Income Tax). A total of 356 OPO-year observations is included in the final sample.

3.1 Main Variables

We begin by constructing our main variable of interest, the SAC per organ for each OPO, based on prior healthcare research that examined the probable cost components (Held et al. 2020; Cheng et al., 2021; Held et al. 2021; Cheng et al., 2022). The information is extracted from Form

CMS 216-94, and calculated as the total cost reported for the organ divided by the number of total organs procured. We begin with the direct cost per organ from Worksheet A-2 (Organ Acquisition Costs). Worksheet A-2 describes all costs directly associated with each organ acquisition, including those for the surgeon, transportation, medical supplies, laboratory tests, preservation, import, and so on. Next, we calculate the overhead costs including procurement coordination, public and professional education, and administrative support personnel taken from Worksheet B (Cost Allocation – General Service Cost). We also include the executive director's pay, taken either from Worksheet A-1 (Admin and General) or IRS Form 990. Following the Medicare guideline, the overhead acquisition and admin and general costs are allocated based on the total number of organs that the OPO used to allocate costs.[11] In addition, we add the total number of organs, percentage of non-viable organs, number of full-time employees, and total assets for each OPO-year.[12] These variables provide information on the OPOs' resources, volume, and success rates, which may inform us about the costs.

Furthermore, we also collected information about of tissue revenue from the FOIA-obtained files. In addition to solid organs, many OPOs procure human tissues such as bone and skin and sell them separately in procedures not covered by Medicare. Many of these activities are large in scale and constitute major revenue sources for the OPOs. As this activity may not be life-saving and provides significant revenue for the OPOs, the related resources and cost allocations could supplant the core activity for which the OPOs were created; this may, in turn, influence the OPOs' costs and efficiency.

Finally, we add information on each OPO's designated service area, including the population (Scientific Registry of Transplant Recipients), the number of hospitals from which the OPO acquired organs (Organ Procurement and Transplantation Network), the number of transplant centers to which the OPO delivered organs (Organ Procurement and Transplantation Network),

[11] The OPO reports the number of organs in Worksheet S1 but registers the basis for cost calculation in Worksheet B1. In all but a few cases, this number is equal to the total organs acquired (viable and non-viable). Nevertheless, for consistency with OPO calculations (where the basis for cost calculation takes only the viable organs), we use the number reported in Worksheet B1 for that OPO-year.

[12] Very few OPO-years do not report assets. Where data exists for some years, we supplement any missing years with data from the closest year. Where data is missing for all OPO-years, we supplement with the median assets of kidneys acquired by the OPOs within the same quartiles. Although this measure is not a perfect substitute (since kidneys are a major driver of OPO operations), we believe it should adequately describe the operation needs of the OPO for organ acquisition volume. Furthermore, our results remain consistent when we drop the OPO-years that are missing assets.

and the hospital worker wage index (Centers for Medicare & Medicaid Services). A full list of variable definitions and sources is available in Appendix A.

3.2 Descriptive Statistics

Table 1 lists the data of 51 independent OPOs regarding the procurement of the four major solid organs that constituting 95% of solid organ procurement in the United States. Panel A shows that OPOs procured 280,204 organs across the sample years of 2015–2021. The kidney accounts for the largest number of organs procured, with a total of 152,914 organs (55%), followed by 72,043 livers (26%), 29,322 hearts (10%), and 25,922 lungs (9%). Panel A of Table 1 also shows a steady increase in the number of organs procured over the years, from a total of 32,306 organs in 2015 to 50,682 organs in 2021.

Panel B of Table 1 provides the annual organ procurement statistics per OPO, showing significant variation among our OPOs. For example, the number of kidneys procured by OPOs ranges from 70 to 1,537 organs per year with average of 430 kidneys per year. The variation is similar with the other organs. It is worth noting that that some of the OPOs did not procure any heart or lung in some of the years, therefore the sample size vary across the different organs. Panel C of Table 1 also provides information about the procurement of viable and non-viable organs. The panel shows that, on average, OPOs procure 82 non-viable kidneys (19% or all procured kidneys), 25 non-viable livers (12% of all procured livers), 3 non-viable hearts (4% of all procured heart), and 12 non-viable lungs (16% of all procured lungs).

Table 2, Panel A, describes the total organ procurement industry by providing the total SAC for each organ per year. The total industry size for the four solid organs between 2015 and 2021 was $9.25 billion, with the 2021 cost estimated at $1.8 billion. The total SACs for the kidney amount to $4.7 billion (51% of the industry), followed by $2.4 billion for the liver (26%), $1.1 billion for the heart (12%), and $1 billion for the lung (11%).

Table 2, Panel B, provides information about the average SAC for each organ. The SAC for the kidney, the most sought-after organ, is $31,281 on average and ranges from $20,097 to $47,748. We observe similar variation in other organs, with a liver costing $33,910 on average and ranging from $14,195 to $56,027, a heart costing $36,384 and ranging from $12,893 to $63,397, and a lung costing $36,616 and ranging from $11,902 to $99,859. For kidneys, there is an approximate percentage difference of 137% between the lowest and highest costs. The percentage difference is even more pronounced for other organs and is highest for the lung, at 740%.

Figures 1 to 3 provide a visual representation of the OPO industry. Figure 1 presents the average SAC per organ for each OPO, showing that SAC values vary significantly both among OPOs and across different organ types. However, the figure indicates that the SAC for kidneys varies the least across OPOs, while the SAC for lungs exhibits the highest variability, with a few notable outliers. Figure 2 illustrates the average number of organs procured per OPO, maintaining the same sorting by average SAC per organ as in Figure 1. The figure suggests greater variation in the number of kidneys procured by OPOs compared to other solid organs.

Figure 3 plots the average SAC for each organ against the average number of organs procured by an OPO. The figure shows no clear relationship between cost and organ quantity, and substantial variation in costs persists even when analyzed in relation to procurement volume. For instance, among OPOs that procure approximately 600 kidneys, SAC values range from $20,000 to $35,000—a 75% difference in cost despite the same procurement volume.

Next, in Table 4, we examine the direct and overhead acquisition costs. Direct costs include surgeon fees, various tests, import fees, supplies, medications, and more. These costs are linearly added to the SAC of each organ. We note that, similar to total costs, direct costs vary significantly across OPOs due to factors such as local labor costs and the density of transplant hospitals. The average direct cost for kidney is $16,578, for Liver is $17,336, for Heart is $18,215 and for Lung is $20,184. Overhead costs encompass the expenses that OPOs allocate to various organ transplant-related activities, including coordination, professional training, and public education about the organ procurement process, as well as the personnel responsible for these activities. Unlike direct costs, overhead costs are distributed proportionally to each organ based on the total number of organs procured by the end of the year. Since allocation is based on the number of organs procured, the per-organ overhead costs are not expected to vary significantly among different organs within an OPO. However, we do find some variation across the different overhead costs when the Kidney usually have the highest overhead costs. For example, the support personal cost per organ is $3542 for kidney and only $3,070, $3,309, and $3,218 for Liver, Hear and Lung, respectively.

Table 4 details the operating environment and the resources employed by OPOs. The median OPO possesses assets worth $30.5 million, generates approximately $4.5 million in tissue revenue, employs 120 individuals, collaborates with 27 hospitals, and serves a DSA covering roughly five million people. The median CEO salary is $468,837, with a salary range spanning from $84,762 to $11.3 million.

Based on the presented data, it is evident that OPOs exhibit variability across numerous factors, including cost structure, procurement strategies, and operational environments. Beyond providing this comprehensive overview, the primary objective of this study is to analyze the factors contributing to variations in OPO costs and to determine whether these cost determinants align with OPOs' primary mission of organ procurement.

4 Methodology and Results

4.1 Accounting for different Components of the SAC

In this section, we examine the factors contributing to the significant variations in the SAC of each organ across OPOs. Specifically, we test our hypothesis whether OPO costs vary based on reimbursement mechanisms by analyzing the key cost components using variance decomposition analysis. Our analysis breaks down the SAC structure in accordance with CMS guidelines and Cheng et al. (2021, 2022), identifying primary cost components such as direct costs, administrative overhead, organ yields, success rates, and broader environmental factors that influence procurement. If no cost-shifting occurs, the unexplained variance in our analysis should be minimal, and cost components should consistently explain SAC differences across different organs. However, deviations in the variance pattern may suggest strategic cost-shifting by OPOs. To explore these patterns, we conduct a statistical breakdown of SAC across four major organ types. This is a two-stage approach, which begins with using the following regression:

(1) $$Y_t = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \varepsilon$$

In the first stage of the variant decomposition analysis, Y represents SAC in time t, while $X_1 \ldots X_n$ denote the various cost components. SAC represents the total allocated expenses reported by each OPO for the four primary solid organ types: kidney, liver, heart, and lung. The regression includes multiple covariates representing key cost components identified in prior research as influencing SAC.[13] This step establishes the baseline relationships between cost components and SAC before quantifying their relative contributions to overall cost variance.

[13] A detailed explanation of these cost components can be found in Appendix A.

Table 5 provides the baseline coefficient estimates, offering insights into how various cost components correlate with SAC for each organ type. Notably, direct costs per organ exhibit strong positive correlations with SAC across all organs, with coefficients ranging from 0.816 for kidneys to 0.935 for lungs. Support personnel and coordination costs also significantly impact SAC, with particularly high coefficients for kidney and liver procurement. Additionally, healthcare wage index and total employees show significant positive associations with SAC, indicating that labor costs play a critical role in driving expenses. However, total organs procured and the percentage of non-viable organs are negatively correlated with SAC, suggesting potential cost efficiencies when more organs are successfully procured. Despite these insights, these coefficients do not directly indicate how much each factor contributes to the variation in the costs.

To understand the impact of each cost component, we analyze how much each factor contributes to variations in SAC. We use a variance decomposition approach based on the above baseline regression results to quantify the share of total cost variation explained by each variable. This method follows Hottman et al. (2016) and is similar to the variance decomposition approach used by Eaton et al. (2004) in international trade and labor studies.

This method breaks down the variation in SAC into individual and shared contributions of each cost factor. It does this by adding the direct effect of each covariate to the shared effect with each of the other covariates, as follows.

$$
\begin{aligned}
\hat{\beta}_1 X_1 &= \alpha_1 + \delta_1 Y + \omega_1 \\
\hat{\beta}_2 X_2 &= \alpha_2 + \delta_2 Y + \omega_2 \\
&\dots \\
\hat{\beta}_n X_n &= \alpha_n + \delta_n Y + \omega_n \\
\hat{\varepsilon} &= \alpha_{n+1} + \delta_{n+1} Y + \omega_{n+1}
\end{aligned}
\tag{2}
$$

The decomposition ensures that the sum of all contributions, including the residual, equals one[14], verifying the accuracy of our analysis. A detailed mathematical validation of this approach is provided in Appendix B.

[14] The variance decomposition may yield negative coefficients due to the presence of negative covariates. However, this does not impact the interpretation of other, positive coefficients. As the sum of all coefficients is one, combining negative and positive coefficients is feasible for analyzing the overall effect of the cost drivers on SAC.

Table 6 shows the variance decomposition results for SAC across different organs and OPOs. The findings highlight significant discrepancies in cost allocation among organ types, with kidneys showing a notably higher unexplained variance compared to other solid organs. Specifically, the residual variance for kidneys is 21%, while for other organs it ranges from 7% to 14%. This higher residual for kidneys suggests potential inefficiencies within the OPOs' cost structures or greater strategic discretion by the OPO’s managers. It also raises concerns about the transparency and accuracy of cost reporting practices in the organ procurement market. Overall, these results indicate differences in cost structures based on reimbursement mechanisms, supporting our Hypothesis 1 (H1).

Looking at the different cost components in the variance decomposition analysis in Table 6, the results indicate large variations in cost components between the different organs. Direct costs account for the largest portion of SAC, but they range from 30% for kidneys to 70% for livers, 73% for hearts, and 76% for lungs. On the other hand, we also find significant differences in overhead costs (Support Personnel, Coordinator, Public and Professional Education, and Executive pay). Overhead costs account for 37.7% for kidneys, but only 18.5%, 17.9%, and 8.6% for liver, heart, and lung, respectively. Since Medicare requires OPOs to allocate overhead costs proportionally across all organs based on the number of organs procured, the higher share of overhead assigned to kidneys provides more support to our Hypothesis 1 and suggests that it is plausible that OPOs are moving costs from other organs to kidney either to offset inefficiencies or to strategically manage their fiscal metrics.

It is noteworthy that tissue revenue contributes only minimally to explaining the costs; this is puzzling because tissue operations should, in theory, aid OPOs in reducing costs and enhancing efficiency. Additionally, geographical factors such as wages, prices, hospital cooperation, and DSA population densities have a minimal impact on the cost variance.

This evidence highlights the need for greater transparency and a more standardized approach to costing within OPOs to ensure transparent organ pricing and efficient operations. Our results also provide empirical support for the recent report and recommendations of the OIG at the HHS, which suggested that changes to the cost reimbursement policy may be warranted and emphasized the need to clarify overhead reimbursement requirements—a measure that could save Medicare a significant amount of money.

4.2 Determinants of OPOs' (High and Low) Costs

Next, we examine Hypothesis 2 by looking at the relationship between SAC and various cost components to determine whether OPOs that invest more in operations—and consequently incur higher overhead costs—have greater incentives to shift costs and enhance their revenue. To explore Hypothesis 2, we categorize OPOs into two groups for each organ—high-cost and low-cost—based on whether their total acquisition cost per organ exceeds or falls below the median. This classification allows us to assess whether higher-cost OPOs exhibit different cost-shifting behaviors compared to their lower-cost counterparts, providing deeper insight into the financial incentives that may influence cost allocation strategies within the industry

Table 7 presents the variance decomposition results for SAC across both high- and low-cost samples. Columns 3 through 8 indicate no significant difference in the unexplained variance between the high- and low-cost groups for liver, heart, and lung transplants. Specifically, the residual variance for low-cost liver transplants is 16.6%, compared to 17.9% for high-cost liver transplants. Similarly, for heart transplants, the residual variance is 14.5% in the low-cost sample versus 14.6% in the high-cost sample, while for lung transplants, the figures are 23.4% and 23.1%, respectively. These results suggest that cost differences do not substantially influence the proportion of unexplained variance across these organ categories, indicating a relatively consistent cost allocation pattern regardless of cost grouping.

However, a notable deviation is observed in kidney transplants (Columns 1 and 2), where the residual variance differs significantly between cost groups. The residual variance for low-cost kidney transplants is 17.0%, whereas for high-cost kidney transplants, it surges to 40.7%. This substantial discrepancy suggests that cost-shifting mechanisms may play a more pronounced role in the acquisition costs that the high-cost kidney OPOs bill to Medicare. The significant higher residual in high-cost kidney sample provides support for our Hypothesis 2 that OPOs due to the reimbursement mechanism tend to shift more costs to kidney than other organs. The result also raises important questions regarding potential inefficiencies, pricing strategies, or cross-subsidization practices within the OPO financial model and underscore the need for further investigation into the specific cost component contributing to this unequitable resource allocation in organ transplantation.

To examine the impact of cost components on total acquisition costs, we use the traditional Oaxaca-Blinder method to decompose for high- and low-cost samples into the different component.

This statistical method decomposes the difference in the means of a dependent variable between two groups into two components: one attributable to differences in the mean values of the independent variables and the other to differences in the effects of these variables (Kitagawa, 1955; Blinder, 1973; Oaxaca, 1973). A key advantage of this approach is that it enables us to quantify and assign a dollar value to the explained portion of the cost disparity.

The basic objective of the Oaxaca–Blinder method is to estimate separate linear regression models for each group and compare the predicted outcomes under a counterfactual scenario. To decompose the cost gap between high- and low-cost OPOs, we first estimate the following models:

$$\begin{gathered} Y_{high} = \beta_{high} X_{high} + \varepsilon_{high} \\ Y_{low} = \beta_{low} X_{low} + \varepsilon_{low} \end{gathered} \tag{3}$$

where Y represents the cost of the organ, X is a vector of explanatory variables, β is a vector of coefficients, and ε is an error term. The subscripts "high" and "low" denote costs above and below the median for OPOs. Then, we compute the mean predicted cost for each group as

$$\begin{gathered} Mean(Y_{high}) = Mean(X_{high}) * \beta_{high} \\ Mean(Y_{low}) = Mean(X_{low}) * \beta_{low} \end{gathered} \tag{4}$$

The difference between these two means is the observed cost gap:

$$\begin{aligned} & Mean(Y_{high}) - Mean(Y_{low}) \\ & \quad = \underbrace{[Mean(X_{high}) - Mean(X_{low})] * \beta_{high}}_{a} + \underbrace{[\beta_{high} - \beta_{low}] * Mean(X_{low})}_{b} \end{aligned} \tag{5}$$

The first component, part (a) in Equation (5), represents the portion of the cost gap explained by differences in the mean values of the explanatory variables. Part (b) of Equation (5) represents the portion of the cost gap that remains unexplained by differences in the mean values of the explanatory variables. In contrast, part (a) captures the portion of the cost gap attributable to observable differences in the explanatory variables, evaluated using the coefficients for high-cost OPOs. The unexplained component, part (b), may reflect variations in unobserved characteristics, such as operational inefficiencies, strategic pricing decisions, or other factors not captured by the model.

Panels A through D of Table 8 present the Oaxaca–Blinder decomposition results, analyzing cost differentials between high- and low-cost OPOs to identify the key cost components driving organ acquisition costs. Column (1) of each panel reports the mean SAC for high-cost OPOs, while Column (2) reports the mean SAC for low-cost OPOs. Columns (3) and (4) provide the linear regression estimates from Equation (3) for high- and low-cost OPOs, respectively. Our primary focus is on Column (5), which quantifies the explained portion of the cost gap in dollar terms, representing differences attributable to observable cost drivers. Column (6) reports the unexplained portion of the cost gap, which may reflect variations in unobserved factors such as operational inefficiencies or discretionary pricing. Finally, Column (7) presents the total cost gap as the sum of the explained and unexplained components.

Table 8 reinforces our findings from Table 8 by applying the Oaxaca–Blinder decomposition to quantify the percentage of the Total (cost) Difference that can be explained by cost components. The results show that while only 49% of the cost differential in kidney transplants is explained, the cost differential in other organs is explained at rates ranging from 61% to 72%. These findings provide additional support for Hypothesis 2 and suggest that kidney transplantation may be subject to pricing strategies or cost-shifting mechanisms.

In addition, Table 8 presents the average SAC for high- and low-cost OPOs for each organ in Columns (1) and (2). The mean SAC for low-cost OPOs ranges from $26,847 (lungs) to $28,324 (heart), while the mean SAC for high-cost OPOs ranges from $35,659 (kidneys) to $47,255 (lungs). Notably, the magnitude of cost differences between high- and low-cost OPOs varies substantially by organ type, with differences ranging from $8,586 for kidneys to $20,407 for lungs. However, as shown in Column (5), which reports the difference in mean SAC (USD), the direct cost component explains 69.5% ($14,179) of the SAC difference for lungs, 53.4% ($8,549) for hearts, and 50.8% ($6,279) for livers. The variation in direct costs can be attributed to differences in transportation logistics, hospital costs, and other operational structures (e.g., surgeon salaries). In contrast, direct costs explain only 19.8% ($1,701) of the SAC difference for kidneys, suggesting that other factors play a more significant role in cost variation for kidney transplants.

Next, we examine the impact of overhead cost components—including support personnel, coordinator costs, public and professional education, and executive compensation—on SAC differences. For kidneys, overhead costs explain 25.2% ($2,164) of the cost difference, whereas for livers, lungs, and hearts, overhead costs explain only 12.6% ($1,559), 12.9% ($2,068), and 3%

($607), respectively. These results provide further evidence that some OPOs leverage Medicare's reimbursement structure for kidney transplants, shifting more overhead costs to kidneys than to other organs in an effort to maximize revenue.

To further explore cost structures, we conduct an untabulated analysis examining OPOs' SAC patterns over time. Our findings indicate that for 10 OPOs, SAC remains consistently below the median across all organs, whereas for eight OPOs, SAC remains consistently above the median. Interestingly, six OPOs exhibit an above-median SAC for kidneys but below-median SACs for all other organs, while four OPOs follow the opposite pattern. The remaining OPOs exhibit a mixed SAC structure, with some organs priced above and others below the median. Additionally, when tracking SAC fluctuations over time, we find that eight OPOs consistently report high SACs across all organs, while five OPOs maintain persistently low SACs across all organs. The remaining OPOs fluctuate around the median at least once during the sample period.

These results suggest that while some OPOs maintain relatively stable SAC structures, others exhibit greater variability, potentially driven by strategic financial decisions. The distinct cost dynamics observed in kidney transplants—particularly the high unexplained cost component and significant role of overhead costs—raise important questions regarding potential cost-shifting practices. As regulatory scrutiny increases, further research is needed to better understand the financial strategies of OPOs and ensure greater transparency and fairness in organ acquisition costs.

5 Conclusions

This paper investigates the incentives that shape strategic cost allocation within the nonprofit organ transplantation system in the United States, building on the August 2023 OIG audit report cautioning that "there is an incentive for OPOs to maximize their Medicare reimbursement by shifting the costs of procuring non-kidney organs to kidneys." [15] Using comprehensive data from the annual cost reports of 51 independent OPOs from 2015 to 2021, which we obtained under the FOIA and supplemented with data from sources such as the CMS and the OPTN, we conducted a thorough analysis of the costs tied to organ procurement.

This study provides empirical evidence of cost-shifting practices within the U.S. organ procurement system, suggesting that OPOs allocate overhead costs disproportionately to kidney

[15] Office of Inspector General Report No. A-09-21-03020, August 2023, Page 14.

transplants due to Medicare's full reimbursement policy. Our findings indicate that kidney acquisition costs exhibit significantly higher unexplained variance than other organs, suggesting potential inefficiencies and strategic cost allocation decisions by OPOs. The Oaxaca–Blinder decomposition further highlights that direct costs explain only a fraction of the cost disparities in kidney transplants, while overhead costs account for a larger portion than in other organ categories.

These findings raise concerns about the transparency and regulatory oversight of the OPO industry, particularly given the monopolistic structure of OPOs and their autonomy in cost determination. The financial and policy implications of our research suggest that CMS should refine its reimbursement policies to minimize cost-shifting opportunities and enforce stricter guidelines on overhead allocation. Additionally, increased regulatory oversight and standardized cost reporting mechanisms could help address inefficiencies and ensure that organ procurement costs reflect actual operational expenses rather than strategic financial management practices. This urgency was further underscored by the second Trump administration's decision to limit the allocation of overhead costs in National Institutes of Health grants, reflecting a broader push to address overhead spending in publicly funded healthcare programs.

As the demand for organ transplants continues to rise, improving the financial sustainability and efficiency of the organ procurement system is crucial. Our study underscores the need for policymakers to implement reforms that enhance cost transparency, reduce financial distortions, and ensure that OPOs operate in a manner that prioritizes both fiscal responsibility and patient outcomes. Future research could expand upon these findings by examining the long-term effects of policy changes on cost allocation practices and exploring alternative reimbursement models that promote fairness and efficiency in organ procurement.

<u>References</u>

Anderson, M. C., Banker, R. D., & Janakiraman, S. N. (2003). Are selling, general, and administrative costs "sticky"? Journal of Accounting Research, 41(1), 47–63.

Baber, W. R., Fairfield, P. M., & Haggard, J. A. (1991). The effect of concern about reported income on discretionary spending decisions: The case of research and development. The Accounting Review, 66(4), 818–829.

Balakrishnan, R., & Gruca, T. S. (2008). Cost stickiness and core competency: A note. Contemporary Accounting Research, 25(4), 993–1006.

Balakrishnan, R., Petersen, M. J., & Soderstrom, N. S. (2004). Does capacity utilization affect the "stickiness" of cost? Journal of Accounting, Auditing & Finance, 19(3), 283–299.

Banker, R. D., Byzalov, D., & Plehn-Dujowich, J. M. (2014). Demand uncertainty and cost behavior. The Accounting Review, 89(3), 839–865.

Banker, R. D., Potter, G., & Schroeder, R. G. (1995). An empirical analysis of manufacturing overhead cost drivers. Journal of Accounting and Economics, 19(1), 115-137.

Blinder, A. S. (1973). Wage discrimination: Reduced form and structural estimates. Journal of Human Resources, 436-455.

Bragg-Gresham, J. L., Peters, T. G., Vaughan, W. P., Held, P., McCormick, F., & Roberts, J. P. (2024). The cost of procuring deceased donor livers: Evidence from US Organ Procurement Organization cost reports, 2013–2018. Clinical Transplantation, 38(9), e15452.

Brickley, J. A., & Van Horn, R. L. (2002). Managerial incentives in nonprofit organizations: Evidence from hospitals. The Journal of Law and Economics, 45(1), 227-249.

Bushee, B. J. (1998). The influence of institutional investors on myopic R&D investment behavior. The Accounting Review, 73(3), 305–333.

Calleja, K., Steliaros, M., & Thomas, D. C. (2006). A note on cost stickiness: Some international comparisons. Management Accounting Research, 17(2), 127–140.

Chan, A., & Roth, A. E. (2024). Regulation of organ transplantation and procurement: A market-design lab experiment. *Journal of Political Economy*, 132(11), 3827–3866.

Chen, C. X., Lu, H., & Sougiannis, T. (2012). The agency problem, corporate governance, and the asymmetrical behavior of selling, general, and administrative costs. Contemporary Accounting Research, 29(1), 252–282.

Chen, C. X., Lu, H., & Sougiannis, T. (2013). Managerial overconfidence and cost stickiness. Working Paper.

Chen, C. X., Gores, T., & Nasev, J. (2013). Managerial overconfidence and cost stickiness. Working Paper.

Cheng, X. S., Han, J., Bragg-Gresham, J. L., Held, P. J., Busque, S., Roberts, J. P., Tan, J. C., Scandling, J. D., Chertow, G. M., & Dor, A. (2022). Trends in cost attributable to kidney transplantation evaluation and waiting list management in the United States, 2012-2017. JAMA Network Open, 5(3), e221847.

Cheng, X. S., Held, P. J., Dor, A., Bragg-Gresham, J. L., Tan, J. C., Scandling, J. D., & Roberts, J. P. (2021). The organ procurement costs of expanding deceased donor organ acceptance criteria: Evidence from a cost function model. American Journal of Transplantation, 21(11), 3694-3703.

Cohen, D. A., Dey, A., & Lys, T. Z. (2008). Real and accrual-based earnings management in the pre- and post-Sarbanes-Oxley periods. The Accounting Review, 83(3), 757–787.

Danzon, P. M. (1982). Hospital ‘profits’: The effects of reimbursement policies. Journal of Health Economics, 1(1), 29-52.

Dechow, P. M., & Sloan, R. G. (1991). Executive incentives and the horizon problem: An empirical investigation. Journal of Accounting and Economics, 14(1), 51–89.

DeRoos, L. J., Zhou, Y., Marrero, W. J., Tapper, E. B., Sonnenday, C. J., Lavieri, M. S., Hutton, D. W., & Parikh, N. D. (2021). Assessment of national organ donation rates and organ procurement organization metrics. JAMA Surgery, 156(2), 173-180.

Dierynck, B., Landsman, W. R., & Renders, A. (2012). Do managerial incentives drive cost behavior? Evidence about the role of the zero earnings benchmark for labor cost behavior in private Belgian firms. The Accounting Review, 87(4), 1219–1246.

Dranove, D. (1988). Pricing by non-profit institutions: The case of hospital cost-shifting. Journal of Health Economics, 7(1), 47–57. https://doi.org/10.1016/0167-6296(88)90004-5

Eaton, J., Kortum, S., & Kramarz, F. (2004). Dissecting trade: Firms, industries, and export destinations. American Economic Review, 94(2), 150-154.

Eldenburg, L., & Kallapur, S. (1997). Changes in hospital service mix and cost allocations in response to changes in Medicare reimbursement schemes. Journal of Accounting and Economics, 23(1), 31-51.

Eldenburg, L., & Soderstrom, N. (1996). Accounting system management by hospitals operating in a changing regulatory environment. The Accounting Review, 71(1), 23–42.

Eldenburg, L. G., Gunny, K. A., Hee, K. W., & Soderstrom, N. (2011). Earnings management using real activities: Evidence from nonprofit hospitals. The Accounting Review, 86(5), 1605-1630.

Eldenburg, L. G., Krishnan, H. A., & Krishnan, R. (2017). Management accounting and control in the hospital industry: A review. Journal of Governmental & Nonprofit Accounting, 6(1), 52-91.

Foster, G., & Gupta, M. (1990). Manufacturing overhead cost driver analysis. Journal of Accounting and Economics, 12(1-3), 309-337.

Graham, J. R., Harvey, C. R., & Rajgopal, S. (2005). The economic implications of corporate financial reporting. Journal of Accounting and Economics, 40(1–3), 3–73.

Hartlieb, S., Loy, T. R., & Wagenhofer, A. (2020). Optimism and profit-based incentives in cost stickiness: An experimental study. Journal of Management Control, 31(4), 377–403.

Held, P. J., Bragg-Gresham, J. L., Peters, T. G., Chertow, G. M., McCormick, F., & Roberts, J. P. (2020). The cost of procuring deceased donor kidneys: Evidence from OPO cost reports 2013-2017. American Journal of Transplantation, 20(4), 1087-1094.

Held, P. J., Bragg-Gresham, J. L., Peters, T. G., McCormick, F., Chertow, G., Vaughan, W. P., & Roberts, J. P. (2021). Cost structures of US organ procurement organizations. Transplantation, 105(12), 2612-2619.

Held, P. J., McCormick, F., Ojo, A., & Roberts, J. P. (2016). A cost-benefit analysis of government compensation of kidney donors. American Journal of Transplantation, 16(3), 877-885.

Holzhacker, M., Krishnan, R., & Mahlendorf, M. D. (2015). The impact of changes in regulation on cost behavior. Contemporary Accounting Research, 32(2), 534–566.

Hottman, C. J., Redding, S. J., & Weinstein, D. E. (2016). Quantifying the sources of firm heterogeneity. The Quarterly Journal of Economics, 131(3), 1291-1364.

Kama, I., & Weiss, D. (2013). Do earnings targets and managerial incentives affect sticky costs? Journal of Accounting Research, 51(1), 201–224.

Kitagawa, E. M. (1955). Components of a difference between two rates. Journal of the American Statistical Association, 50(272), 1168-1194.

Krishnan, R., & Yetman, M. H. (2011). Institutional drivers of reporting decisions in nonprofit hospitals. Journal of Accounting Research, 49(4), 1001-1039.

McGowan, A. S., & Vendrzyk, V. P. (2002). The relation between cost shifting and segment profitability in the defense-contracting industry. The Accounting Review, 77(4), 949-969.

Miller, J. G., & Vollmann, T. E. (1985). The hidden factory. Harvard Business Review, 63(5), 142–150.

Naylor, K. L., McKenzie, S., Cherry, C., & et al. (2017). Evaluation of a hockey deceased organ donation awareness campaign: A population-based cohort study. Canadian Journal of Kidney Health and Disease, 4, 1-8.

Oaxaca, R. (1973). Male-female wage differentials in urban labor markets. International Economic Review, 14(3), 693-709.

Rosenberg, P., Ciccarone, M., Seeman, B., Washer, D., Martin, G., Tse, J., & Lezama, E. (2020). Transforming organ donation in America. Bridgespan.org.

Roychowdhury, S. (2006). Earnings management through real activities manipulation. Journal of Accounting and Economics, 42(3), 335–370.

Siminoff, L. A., Gordon, N., Hewlett, J., & Arnold, R. M. (2001). Factors influencing families' consent for donation of solid organs for transplantation. JAMA, 286(1), 71–77.

Spardy, J., Concepcion, J., Yeager, M., Andrade, R., Braun, H., & Elkbuli, A. (2023). National analysis of recent trends in organ donation and transplantation in the United States: Toward optimizing care delivery and patient outcomes. The American Surgeon, 89(12), 5201-5209.

Thomas, J. K., & Tung, S. (1992). Cost manipulation incentives under cost reimbursement: Pension costs for defense contracts. The Accounting Review, 67(4), 691-711.

Weiss, D. (2010). Cost behavior and analysts' earnings forecasts. The Accounting Review, 85(4), 1441–1471.

Appendix A – Variable Definition

Variable	Definition
SAC - Standard Acquisition Charge	The total expenses the OPO has determined and allocated for each of the four primary solid organ types: kidney, liver, heart, and lung. This data is sourced from Form CMS 216-94, which was obtained through the Freedom of Information Act. Specifically, the information is derived from Worksheet B, titled "Cost Allocation," under the "General Services Costs" section, Column 11, labeled "Total Expenses."
SAC / Organ	The SAC divided by the total number of organs used for cost allocation. The count of organs used for this purpose is derived from Form CMS 216-94, Worksheet B1, titled "Cost Allocation Statistical Basis," Column 8, labeled "Organ Acquisition Costs (Number Organs)."
Direct Cost / Organ	The organ-specific direct cost (sourced from Form CMS 216-94, Worksheet A2, titled "Organ Acquisition Costs," Column 3, labeled "Total," Row 23, titled "Total Organ Acquisition Cost"), divided by the total number of organs designated for cost allocation, (derived from Form CMS 216-94, Worksheet B1, titled "Cost Allocation Statistical Basis," Column 8, labeled "Organ Acquisition Costs (Number Organs)"). The direct cost encompasses expenses such as operating room charges, screening, surgeon fees, import fees, laboratory costs, and more.
Support Personnel / Organ	The cost associated with organ-specific support personnel, divided by the total number of organs. This includes expenses related to administration, accounting, medical director, office salaries, and office professional education. The calculation is performed by first determining the ratio of the aforementioned costs to the total administrative and general expenses, as sourced from Form CMS 216-94, Worksheet A1, titled "Admin and General Expenses," Column 3, labeled "Total." This ratio is then multiplied by the administrative and general costs allocated for each organ, as indicated in Form CMS 216-94, Worksheet B, titled "Cost Allocation," Column 10, labeled "Admin & General." The resulting value is then divided by the total number of organs designated for cost allocation, which is derived from Form CMS 216-94, Worksheet B1, titled "Cost Allocation Statistical Basis," Column 8, labeled "Organ Acquisition Costs (Number Organs)."
Coordinator Cost / Organ	The cost associated with organ-specific overhead procurement coordination, divided by the total number of organs. The calculation is performed by first determining the ratio of procurement coordination expenses, as sourced from Form CMS 216-94, Worksheet A, Column 7, labeled "Net Cost For Cost Allocation," Row 9, titled "Procurement Coordinators," to the total overhead cost. This total overhead cost is derived from Form CMS 216-94, Worksheet B, titled "Cost Allocation," Column 2, labeled "Net Cost For Alloc.," Row 2 titled "Organ Acquisitions." This ratio is then multiplied by the overhead cost allocated for each specific organ type, as indicated in Form CMS 216-94, Worksheet B, Column 8, labeled "Organ Acquisition Costs." The resulting value is then divided by the total number of organs designated for cost allocation.
Public Education Cost / Organ	The cost associated with organ-specific overhead public education, divided by the total number of organs. The calculation is performed by first determining the ratio of public education expenses, as sourced from Form CMS 216-94, Worksheet A, Column 7, labeled "Net Cost For Cost Allocation," Row 11, titled "Public Education," to the total overhead cost. This total overhead cost is derived from Form CMS 216-94, Worksheet B, titled "Cost Allocation," Column 2, labeled "Net Cost For Alloc.," Row 2, titled "Organ Acquisitions." This ratio is then multiplied by the overhead cost allocated for

	each specific organ type, as indicated in Form CMS 216-94, Worksheet B, Column 8, labeled "Organ Acquisition Costs." The resulting value is then divided by the total number of organs designated for cost allocation.
Year	Categorical variable describing the year of operation (2015–2021).
Total Organs Procured	The total count of each organ type procured, encompassing both viable and non-viable organs. This data is sourced from Form CMS 216-94, Worksheet S1, Part 1, titled "OPO Statistics."
Healthcare Wage Index	Yearly CMS Wage Index by the headquarter state reported in Form CMS 216-94, from https://www.cms.gov/medicare/payment/prospective-payment-systems/skilled-nursing-facility-snf/wage-index.
Total Assets	The total assets reported on the OPO's balance sheet, sourced from Form CMS 216-94, Worksheet E, titled "Balance Sheet." If data is missing for specific years, we supplement it using information from the closest available year. In cases where data is absent across all years for a particular OPO, we utilize the median assets of OPOs within the same quartile of acquired kidneys as a supplementary measure.
Professional Education / Organ	The cost associated with organ-specific overhead professional education, divided by the total number of organs. The calculation is performed by first determining the ratio of professional education expenses, as sourced from Form CMS 216-94, Worksheet A, in Column 7, labeled "Net Cost For Cost Allocation," Row 10, titled "Professional Education," to the total overhead cost. The total overhead cost is derived from Form CMS 216-94, Worksheet B, titled "Cost Allocation," Column 2, labeled "Net Cost For Alloc.," Row 2, titled "Organ Acquisitions." This ratio is then multiplied by the overhead cost allocated for each specific organ type, as indicated in Form CMS 216-94, Worksheet B, Column 8, labeled "Organ Acquisition Costs." The resulting value is then divided by the total number of organs designated for cost allocation.
Transplant Centers	The number of transplant centers to which the OPO provided organs in a year, as provided by a data request from the United Network for Organ Sharing https://optn.transplant.hrsa.gov/data/view-data-reports/request-data/.
Percent Non-Viable Organs	The ratio of non-viable organs procured to the total organs procured, for each organ type. Both values are derived from Form CMS 216-94, Worksheet S1, Part 1, titled "OPO Statistics."
Executive Director Pay / Organ	The total CEO compensation, divided by the total number of organs. The calculation is performed by first determining the ratio of CEO pay expenses to the total administrative and general expenses, as sourced from Form CMS 216-94, Worksheet A1, titled "Admin and General Expenses," Column 3, labeled "Total." This ratio is then multiplied by the administrative and general costs allocated for each specific organ type, as indicated in Form CMS 216-94, Worksheet B, titled "Cost Allocation," Column 10, labeled "Admin & General." The resulting value is then divided by the total number of organs designated for cost allocation, which is derived from Form CMS 216-94, Worksheet B1, titled "Cost Allocation Statistical Basis," Column 8, labeled "Organ Acquisition Costs (Number Organs)." In instances where CEO pay is not provided in Form CMS 216-94, the information is supplemented from the IRS form 990.
Tissue Revenue	The OPO's tissue revenue. This data is sourced from Form CMS 216-94, either from Worksheet E1 or E2 if tissue revenue is reported there. If tissue revenue is not available in the worksheets, it is calculated by manually summing the revenues for cornea, bone, and skin from Worksheet S1.
Procurement Hospitals	The number of hospitals from which the OPO procured organs in a year, as provided by a data request from the United Network for Organ Sharing.
DSA Population	The population within the OPO's Designated Service Area, as sourced from the Annual Reports of the Scientific Registry of Transplant Recipients, from https://www.srtr.org/.

Total Employees	The total number of OPO employees. This data is sourced from Form CMS 216-94, Worksheet S1, Part 3, titled "Full Time Employees," Row 2, labeled "Total FTEs."

Appendix B: Theoretical Foundation for the Variance Decomposition Methodology

The contribution of variance X_k to variance of Y is defined as

$$V_k = var\left(\widehat{\beta_k}X_k\right) + \sum_{l:\, l=1, l\neq k}^{n} cov\left(\widehat{\beta_k}X_k, \widehat{\beta}_l X_l\right)$$

We have to theoretically show that $\frac{V_k}{var(Y)} = \widehat{\delta_k}$, with $\widehat{\delta_k}$ as defined in equation 2 of Section 4.1. First, note that $var\left(\widehat{\beta_k}X_k\right) = cov(\widehat{\beta_k}X_k, \widehat{\beta_k}X_k)$, so V_k can be simplified to

$$V_k = \sum_{l:\, l=1}^{n} cov\left(\widehat{\beta_k}X_k, \widehat{\beta}_l X_l\right)$$

The proof consists of three steps.

Step 1: We will try to simplify V_k first. Replacing $\widehat{\beta_k}X_k = \alpha_k + \widehat{\delta_k}Y + \widehat{\epsilon_k}$ and $\widehat{\beta}_l X_l = \alpha_l + \widehat{\delta}_l Y + \widehat{\epsilon}_l$ for all value of l in V_k, we have

$$V_k = \sum_{l:\, l=1}^{n} cov\left(\alpha_k + \widehat{\delta_k}Y + \widehat{\epsilon_k}, \alpha_l + \widehat{\delta}_l Y + \widehat{\epsilon}_l\right)$$

Note that we have $cov\left(\alpha_k + \widehat{\delta_k}Y + \widehat{\epsilon_k}, \alpha_l + \widehat{\delta}_l Y + \widehat{\epsilon}_l\right) = cov\left(\widehat{\delta_k}Y, \widehat{\delta}_l Y\right) + cov(\widehat{\epsilon_k}, \widehat{\epsilon}_l)$ because

- α_k, α_l are constants and
- Y and $\widehat{\epsilon_k}$ are independent and
- Y and $\widehat{\epsilon}_l$ are independent.

Also, we can write $cov\left(\widehat{\delta_k}Y, \widehat{\delta}_l Y\right) = \widehat{\delta_k}\widehat{\delta}_l cov(Y, Y) = \widehat{\delta_k}\widehat{\delta}_l var(Y)$ because

- $\widehat{\delta_k}$, $\widehat{\delta_l}$ are constants and
- $cov(Y, Y) = var(Y)$.

Therefore, we can simplify V_k as

$$V_k = \sum_{l:\, l=1}^{n} \left[\widehat{\delta_k}\widehat{\delta}_l var(Y) + cov(\widehat{\epsilon_k}, \widehat{\epsilon}_l)\right] = \widehat{\delta_k} var(Y) \sum_{l:\, l=1}^{n} \widehat{\delta}_l + cov\left(\widehat{\epsilon_k}, \sum_{l=1}^{n} \widehat{\epsilon}_l\right)$$

where the second equation uses

$$\sum_{l:\,l=1}^{n} cov(\widehat{\epsilon_k}, \widehat{\epsilon_l}) = cov\left(\widehat{\epsilon_k}, \sum_{l=1}^{n} \widehat{\epsilon_l}\right)$$

<u>Step 2:</u> We use regression equations to further simplify V_k. Note that

$$Y = \alpha + \sum_{k=1}^{n} \widehat{\beta_k} X_k \; + \; \hat{u}$$

Replacing $\widehat{\beta_k} X_k$ with $\alpha_k + \widehat{\delta_k} Y \; + \; \widehat{\epsilon_k}$ for all k in the equation above, we have

$$Y = \alpha + \sum_{k=1}^{n} \left[\alpha_k + \widehat{\delta_k} Y \; + \; \widehat{\epsilon_k}\right] \; + \; \hat{u}$$

The above equation is equivalent to

$$\left(1 - \sum_{l=1}^{n} \widehat{\delta_l}\right) Y - \hat{u} = \sum_{l=1}^{n} \widehat{\epsilon_l} \; + \alpha + \sum_{l=1}^{n} \alpha_l$$

Hence,

$$cov\left(\widehat{\epsilon_k}, \sum_{l=1}^{n} \widehat{\epsilon_l}\right) = cov\left(\widehat{\epsilon_k}, \sum_{l=1}^{n} \widehat{\epsilon_l} + \alpha + \sum_{l=1}^{n} \alpha_l\right) = cov\left(\widehat{\epsilon_k}, \left(1 - \sum_{l=1}^{n} \widehat{\delta_l}\right) Y - \hat{u}\right)$$
$$= -cov(\widehat{\epsilon_k}, \hat{u})$$

The first equation holds because $\alpha + \sum_{l=1}^{n} \alpha_l$ is a constant. In the second equation, we replace $\sum_{k=1}^{n} \widehat{\epsilon_k} \; + \alpha + \sum_{k=1}^{n} \alpha_k$ with $\left(1 - \sum_{l=1}^{n} \widehat{\delta_l}\right) Y - \hat{u}$. The last equation comes from the fact that $cov(\widehat{\epsilon_k}, Y) = 0$ since Y and $\widehat{\epsilon_k}$ are independent.

We have $\widehat{\beta_k} X_k = \alpha_k + \widehat{\delta_k} Y \; + \; \widehat{\epsilon_k}$ and $cov\left(\widehat{\beta_k} X_k, \hat{u}\right) = 0$ because $\hat{u}$ is the residuals in the OLS regression of Y on $X_1, X_2, \ldots, X_n$. It follows that $cov\left(\alpha_k + \widehat{\delta_k} Y \; + \; \widehat{\epsilon_k}, \hat{u}\right) = 0$. Equivalently,

$$cov(\alpha_k, \hat{u}) + cov\left(\widehat{\delta_k} Y, \hat{u}\right) + cov(\widehat{\epsilon_k}, \hat{u}) = 0$$

or $-cov(\widehat{\epsilon_k}, \hat{u}) = \widehat{\delta_k} cov(Y, \hat{u})$ because $cov(\alpha_k, \hat{u}) = 0$ since α_k is a constant. Note that

$$-cov(\widehat{\epsilon_k}, \hat{u}) = \widehat{\delta_k} cov(Y, \hat{u}) = \widehat{\delta_k} cov\left(Y, \alpha_u + \widehat{\delta_u} Y \; + \; \widehat{\epsilon_u}\right) = \widehat{\delta_k} \widehat{\delta_u} var(Y)$$

where the second equation uses $\hat{u} = \alpha_u + \widehat{\delta_u} Y \; + \; \widehat{\epsilon_u}$ and the last equation uses $cov(Y, Y) = var(Y)$. Therefore, using the formula of V_k in step 1:

$$V_k = \widehat{\delta_k} var(Y) \sum_{l=1}^{n} \widehat{\delta_l} + cov\left(\widehat{\epsilon_k}, \sum_{l=1}^{n} \widehat{\epsilon_l}\right) = \widehat{\delta_k} var(Y) \sum_{l=1}^{n} \widehat{\delta_l} + \widehat{\delta_k}\widehat{\delta_u} var(Y)$$
$$= \widehat{\delta_k}\left(\widehat{\delta_u} + \sum_{l=1}^{n} \widehat{\delta_l}\right) var(Y)$$

<u>Step 3:</u> We will show that

$$\widehat{\delta_u} + \sum_{l=1}^{n} \widehat{\delta_l} = 1$$

so it follows that $V_k = \widehat{\delta_k} var(Y)$, which is what we want to show. From step 2, note that we have

$$\left(1 - \sum_{l=1}^{n} \widehat{\delta_k}\right) Y - \hat{u} = \sum_{l=1}^{n} \widehat{\epsilon_k} + \sum_{l=1}^{n} \alpha_k$$

Using $\hat{u} = \alpha_u + \widehat{\delta_u} Y + \widehat{\epsilon_u}$, we get

$$\left(1 - \widehat{\delta_u} - \sum_{l=1}^{n} \widehat{\delta_l}\right) Y = \widehat{\epsilon_u} + \sum_{l=1}^{n} \widehat{\epsilon_l} + \alpha + \alpha_u + \sum_{l=1}^{n} \alpha_l$$

Therefore,

$$cov\left(Y, \left(1 - \widehat{\delta_u} - \sum_{l=1}^{n} \widehat{\delta_l}\right) Y\right) = cov\left(Y, \widehat{\epsilon_u} + \sum_{l=1}^{n} \widehat{\epsilon_l} + \alpha + \alpha_u + \sum_{l=1}^{n} \alpha_l\right)$$

Note that that RHS of the equation above is 0 because

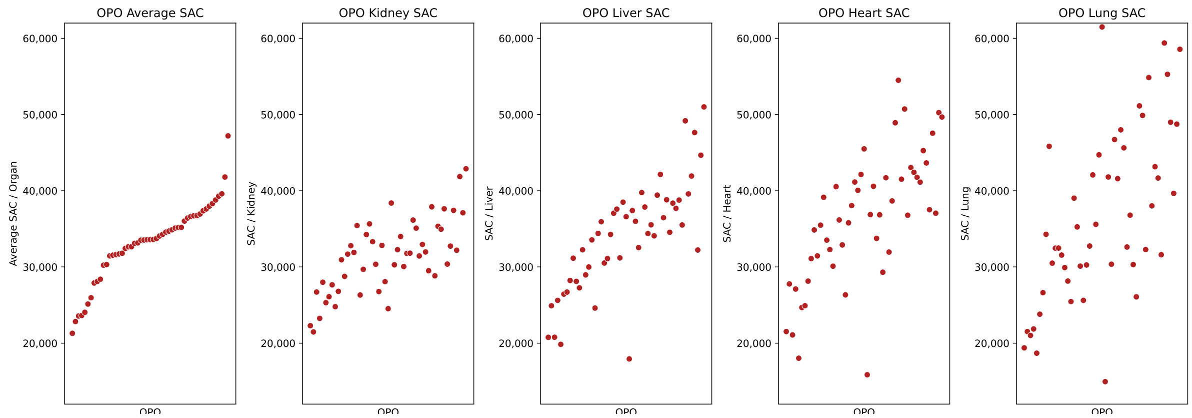
- $\alpha, \alpha_u, \alpha_k$ are constants and
- Y and $\widehat{\epsilon_u}$ are independent and
- Y and $\widehat{\epsilon_k}$ are independent.

The LHS of the equation above is equal to

$$var(Y)\left(1 - \widehat{\delta_u} - \sum_{l=1}^{n} \widehat{\delta_l}\right)$$

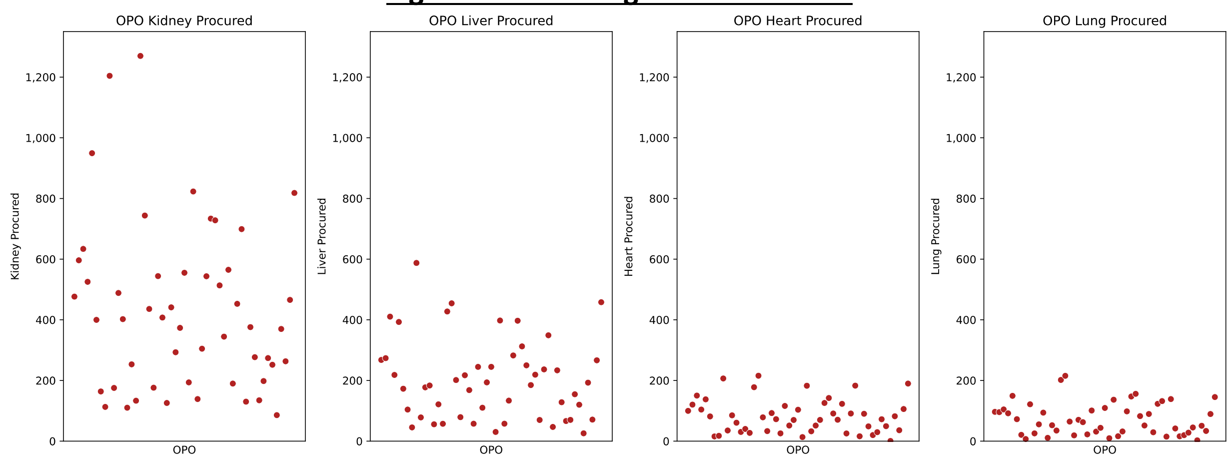
Since $var(Y) > 0$, it is equal to 0 if and only if $1 - \widehat{\delta_u} - \sum_{l=1}^{n} \widehat{\delta_l} = 0$, which is what we need.

Figure 1 – OPO SAC / Organ



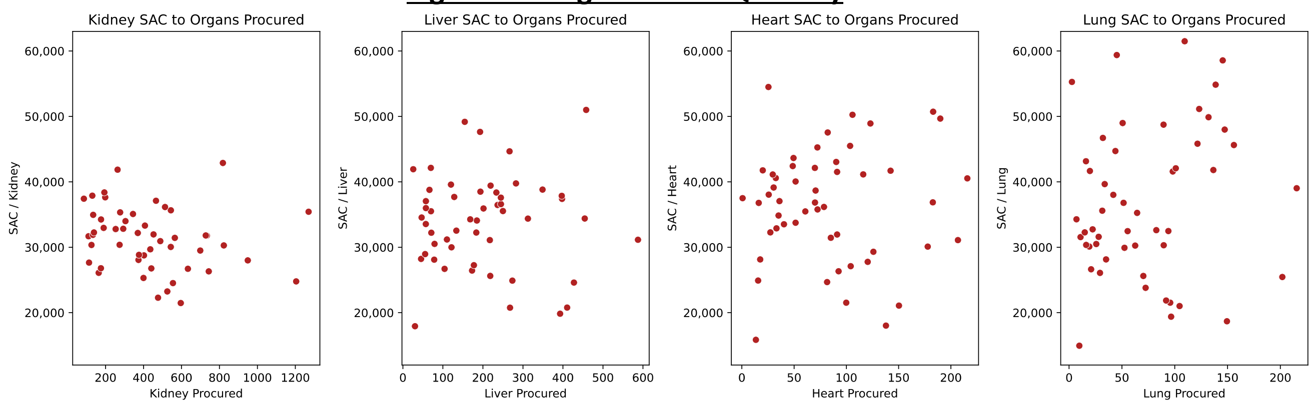
Note: OPOs are ordered on the x-axis based on ascending average standard acquisition charge (SAC) across all organs.

Figure 2 – OPO Organ Procurement



Note: OPOs are ordered on the x-axis based on ascending average standard acquisition charge (SAC) across all organs.

Figure 3 – Organ SAC to Quantity



Note: OPOs are ordered on the x-axis based on ascending number of organs procured, and on the y-axis based on the ascending average standard acquisition charge (SAC) per organ.

Table 1 - OPO Organ Procurement Operations 2015–2021

Panel A details the total count of both viable and non-viable organs procured for the four major solid organs: kidney, liver, heart, and lung. Panel B illustrates the yearly distribution of the number of the four major solid organs procured by OPOs from 2015 to 2021. Panel C illustrates the yearly distribution of the number of non-viable solid organs (again by type) procured by OPOs from 2015 to 2021. The information is derived from Form CMS 216-94, Worksheet S1, Part 1, titled "OPO Statistics," which was obtained through a Freedom of Information Act request.

Panel A - Total Organ Procurement by Year

Year	Kidneys Procured	Livers Procured	Heart Procured	Lung Procured
2015	17,453	8,550	3,284	3,019
2016	18,773	9,218	3,506	3,095
2017	19,735	9,884	3,780	3,732
2018	20,527	9,977	4,026	3,932
2019	23,123	10,497	4,707	4,255
2020	24,143	11,551	4,855	3,896
2021	29,160	12,366	5,164	3,993
Total	**152,914**	**72,043**	**29,322**	**25,922**

Panel B - Descriptive Statistics of Annual OPO Organ Procurement

	Kidneys Procured	Livers Procured	Heart Procured	Lung Procured
Mean	430	202	82	73
STD	287	137	59	57
25%	199	83	35	26
50%	378	179	70	60
75%	591	275	116	105
N	356	356	351	354

Panel C - Descriptive Statistics of Annual Non-Viable Organs

Year	Kidneys Procured	Livers Procured	Heart Procured	Lung Procured
Mean	82	25	3	12
STD	65	24	5	13
25%	34	6	0	2
50%	63	18	2	7
75%	114	36	5	17
N	356	356	351	354

Table 2 - OPO Standard Acquisition Charge

The table presents the total Standard Acquisition Charge (SAC) for the years 2015–2021. The SAC is defined as the total expenses that the OPO has calculated and allocated for each of the four primary solid organ types: kidney, liver, heart, and lung. Panel A provide the information of the total SAC per year, while Panel B provide the descriprive statistics for SAC for a single organ. See Appendix A for full variable definitions.

Panel A – Total OPO SAC ($)

Year	Kidney SAC	Liver SAC	Heart SAC	Lung SAC
2015	504,141,364	272,836,125	108,418,905	98,885,291
2016	548,370,164	293,894,655	116,753,866	112,092,463
2017	594,314,184	324,996,262	127,368,454	129,791,996
2018	637,807,557	338,580,967	143,425,017	158,159,946
2019	721,242,358	350,529,466	184,203,369	168,132,511
2020	758,028,102	419,602,816	194,364,039	159,470,572
2021	969,167,018	451,601,456	208,136,661	157,236,929
Total	4,733,070,747	2,452,041,747	1,082,670,311	983,769,708

Panel B – OPO SAC/Organ ($)

	SAC / Kidney	SAC / Liver	SAC / Heart	SAC / Lung
Mean	31,381	33,910	36,384	36,616
STD	5,339	7,883	10,001	13,213
25%	27,648	28,757	29,458	27,287
50%	31,390	34,284	36,481	34,885
75%	34,608	38,755	42,559	43,928
N	356	356	351	354

Table 3 – OPO - Year Direct and Overhead Costs

The table describes the distribution of direct and various overhead costs for a single organ across all OPOs between 2015 and 2021. Panel A provide the information about the direct costs, while Panel B describes the overhead costs and components. See Appendix A for full variable definitions.

Panel A – Direct Costs Per Organ ($)						
	N	**Mean**	**Std**	**25%**	**50%**	**75%**
Kidney	356	16,579	4,986	12,730	16,064	20,000
Liver	356	17,336	8,339	10,678	15,746	22,920
Heart	351	18,215	9,647	10,497	16,458	25,089
Lung	354	20,184	13,563	9,910	15,448	28,737

Panel B – Overhead Costs Per Organ ($)						
	N	**Mean**	**Std**	**25%**	**50%**	**75%**
Support Personal Cost / Organ						
Kidney	356	3,542	1,796	2,234	4,855	8,578
Liver	356	3,070	1,597	1,960	3,038	4,125
Heart	351	3,309	1,814	1,948	3,137	4,731
Lung	354	3,218	1,949	1,901	2,890	4,290
Professional Education Cost / Organ						
Kidney	356	1,846	1,509	960	1,665	2,445
Liver	356	1,534	1,270	759	1,427	2,064
Heart	351	1,534	1,290	734	1,395	2,064
Lung	354	1,481	1,267	711	1,318	2,034
Coordinator Cost / Organ						
Kidney	356	8,495	3,563	6,147	8,109	10,465
Liver	356	7,899	3,330	5,696	7,537	9,662
Heart	351	7,157	3,068	5,202	6,866	8,899
Lung	354	6,784	2,946	4,926	6,457	8,403
Public Education Cost / Organ						
Kidney	356	1,441	1,460	460	1,049	2,016
Liver	356	1,200	1,218	364	821	1,726
Heart	351	1,173	1,206	338	799	1,636
Lung	354	1,172	1,216	304	804	1,675

<u>Table 4 - OPO Operational Environment</u>

Note: The table describes various OPO operational environment statistics used in the empirical analysis. See Appendix A for full variable definitions.

	N	Mean	Std	25%	50%	75%
HealthCare Wage Index	349	86%	16%	78%	83%	89%
Total Assets ($mill)	349	51.7	63.8	17.2	30.5	66.7
Tissue Revenue ($mill)	349	13.5	50.5	2.0	4.5	8.9
Total Full Time Employees	349	157	173	71	120	170
Procurement Hospitals	349	32.0	20.3	16.0	27.0	40.0
Transplant Hospitals DSA	349	4.5	3.3	2.0	3.0	5.0
DSA Population	349	6,100,514	3,987,783	2,764,902	5,109,861	7,444,344
CEO Pay ($)	349	603,555	747,571	285,018	468,837	595,506

Table 5 - Regression of SAC/Organ on Cost Drivers

Note: The table presents the first stage of the variance decomposition analysis, estimating the linear regression for the major cost drivers in relation to the SAC of the four major solid organs (equation 1). The estimated coefficients provide insight into how various covariates correlate with the SAC of each organ individually. Regression results remain robust when we include OPO and year fixed effects, as well as when we cluster standard errors by OPO. See Appendix A for full variable definitions. P-values are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)
Dependant Variable - SAC / Organ	**Kidney**	**Liver**	**Heart**	**Lung**
Direct Cost / Organ	0.816***	0.920***	0.935***	0.935***
	(0.000)	(0.000)	(0.000)	(0.000)
Support Personal / Organ	1.204***	1.134***	1.133***	0.842***
	(0.000)	(0.000)	(0.000)	(0.000)
Coordinator Cost / Organ	0.767***	0.914***	1.164***	0.795***
	(0.000)	(0.000)	(0.000)	(0.000)
Public Education Cost / Organ	0.698***	0.565***	0.623***	-0.021
	(0.000)	(0.000)	(0.000)	(0.936)
Year	439.951***	290.849***	285.485***	415.223***
	(0.000)	(0.000)	(0.001)	(0.006)
Total Organs Procured	-5.354***	-10.240***	-11.754*	-27.301***
	(0.001)	(0.000)	(0.077)	(0.003)
Healthcare Wage Index	2,543.915**	1,042.203	2,044.708*	-5,541.857**
	(0.025)	(0.355)	(0.091)	(0.012)
Total Assets	-667.568**	-460.059*	-684.799**	-2,655.161***
	(0.013)	(0.089)	(0.023)	(0.000)
Professional Education / Organ	0.774***	0.978***	1.171***	0.595**
	(0.000)	(0.000)	(0.000)	(0.012)
Transplant Centers	-170.934**	-1.497	49.763	-146.676
	(0.026)	(0.985)	(0.570)	(0.362)
Percent Non-Viable Organs	-5,353.143*	-4,043.537*	-4,952.266	-9,202.936***
	(0.062)	(0.079)	(0.124)	(0.000)
Executive Director Pay / Organ	1.468***	1.488***	1.218***	-0.443
	(0.000)	(0.000)	(0.000)	(0.432)
Tissue Revenue	-42.981	-34.633	-71.380**	120.160**
	(0.149)	(0.227)	(0.023)	(0.030)
Procurement Hospitals	14.127	-19.838	-48.385**	-14.150
	(0.570)	(0.400)	(0.034)	(0.722)
DSA Population	1,072.777*	1,178.909**	4.922	2,807.467**
	(0.067)	(0.042)	(0.994)	(0.013)
Total Employees	3.662***	2.443**	2.453*	3.318
	(0.002)	(0.038)	(0.058)	(0.151)
Constant	-882,627.981***	-587,994.164***	-558,102.796***	-816,302.536***
	(0.000)	(0.000)	(0.002)	(0.008)
Observations	349	349	344	347
Adjusted R-squared	0.776	0.893	0.920	0.853

Table 6 – SAC / Organ Variance Decomposition of Main Cost Drivers

Note: The table presents our main results for the variance decomposition of costs and the factors associated with SACs across OPOs and different organs. It assesses the relative contribution of each predictor variable from Table 5 to the overall variability in SAC (Hottman et al., 2016; Eaton, Kortum, and Kramarz, 2004). This method measures the individual and combined impact of each covariate on the variation in the outcome. Designed to evaluate the impact of cost drivers on SAC, the decomposition results, including the residual, sum to one. While the variance decomposition may produce negative coefficients due to negative covariates, it does not affect the interpretation of positive coefficients. Given that the sum of all coefficients equals one, combining negative and positive coefficients provides a comprehensive analysis of the cost drivers' effect on SAC. See Appendix A for full variable definitions.

	(1)	(2)	(3)	(4)
SAC / Organ	**Kidney**	**Liver**	**Heart**	**Lung**
Direct Cost / Organ	30.69%	69.85%	73.09%	76.45%
Support Personal / Organ	15.53%	10.55%	10.50%	6.69%
Coordinator Cost /Organ	16.06%	4.30%	3.22%	2.42%
Public Education Cost / Organ	4.25%	1.61%	1.21%	-0.03%
Year	3.91%	1.17%	1.04%	0.51%
Total Organs Procured	3.44%	-0.52%	-0.57%	-1.40%
Healthcare Wage Index	2.87%	0.41%	0.37%	-1.06%
Total Assets	2.31%	0.32%	-0.16%	-1.28%
Professional Education / Organ	1.67%	2.49%	3.10%	-0.27%
Transplant Centers	1.41%	0.00%	0.08%	-0.59%
Percent Non-Viable Organs	1.16%	0.88%	0.47%	3.77%
Executive Director Pay / Organ	0.24%	-0.50%	-0.16%	-0.18%
Tissue Revenue	-0.45%	-0.33%	-0.37%	0.49%
Procurement Hospitals	-0.60%	0.52%	1.00%	-0.07%
DSA Population	-1.82%	-0.09%	0.00%	1.02%
Total Employees	-2.02%	-0.82%	-0.45%	-0.46%
Residual	21.34%	10.17%	7.63%	13.98%

Table 7 – High Vs. Low SAC Variance Decomposition

Note: The table presents our results for the variance decomposition of costs and the factors associated with high vs. low median SACs across OPOs and different organs. Designed to evaluate the impact of cost drivers on SAC, the decomposition results, including the residual, sum to one. While the variance decomposition may produce negative coefficients due to negative covariates, it does not affect the interpretation of positive coefficients. Given that the sum of all coefficients equals one, combining negative and positive coefficients provides a comprehensive analysis of the cost drivers' effect on SAC. See Appendix A for full variable definitions.

	kidney		**Liver**		**Heart**		Lung	
Median SAC / Organ	***Low Cost OPO***	***High Cost OPO***	***Low Cost OPO***	***High Cost OPO***	***Low Cost OPO***	***High Cost OPO***	***Low Cost OPO***	***High Cost OPO***
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Direct Cost / Organ	34.14%	29.25%	49.72%	59.58%	60.12%	64.18%	40.42%	74.69%
Support Personal / Organ	8.02%	13.41%	9.30%	9.08%	11.11%	12.20%	8.76%	3.52%
Coordinator Cost /Organ	6.83%	8.27%	6.51%	3.31%	7.78%	1.56%	7.80%	2.14%
Public Education Cost / Organ	10.89%	0.13%	0.29%	-0.72%	0.22%	-0.02%	0.43%	-0.76%
Year	2.36%	3.53%	-0.76%	3.71%	-0.63%	1.74%	0.69%	-0.25%
Total Organs Procured	6.05%	-0.74%	6.21%	-6.60%	2.01%	3.18%	4.57%	-1.35%
Healthcare Wage Index	0.93%	0.79%	0.05%	7.09%	0.70%	0.91%	-0.14%	0.28%
Total Assets	4.04%	2.02%	3.77%	-0.61%	5.29%	-0.66%	8.43%	-2.88%
Professional Education / Organ	9.11%	-0.60%	3.28%	1.79%	1.54%	5.58%	2.80%	-0.33%
Transplant Centers	-0.35%	2.13%	1.17%	0.50%	0.08%	0.97%	-0.06%	-0.02%
Percent Non-Viable Organs	2.97%	0.11%	3.32%	0.50%	1.15%	0.15%	2.19%	2.67%
Executive Director Pay / Organ	-0.62%	0.90%	-0.18%	-0.11%	-0.66%	0.81%	0.37%	-2.32%
Tissue Revenue	-0.64%	0.93%	-0.72%	0.51%	-1.26%	0.11%	-0.18%	0.92%
Procurment Hospitals	0.17%	0.11%	3.76%	0.32%	0.59%	-3.40%	4.16%	0.16%
DSA Population	0.60%	-1.77%	-0.62%	2.57%	0.03%	-1.88%	-1.39%	0.17%
Total Employees	-1.48%	0.82%	-1.70%	1.14%	-2.63%	-0.05%	-2.22%	0.07%
Residual	16.99%	40.71%	16.60%	17.94%	14.56%	14.64%	23.37%	23.31%

Table 8 - Blinder–Oaxaca Decomposition of Cost Drivers

Note: Panels A–E detail the Blinder–Oaxaca decomposition, which explains the difference in the means of SAC/Organ between high- and low-cost OPOs (Kitagawa, 1955; Oaxaca, 1973; Blinder, 1973). This categorization is based on whether an OPO's cost is above or below the median for each specific organ. Columns 1 and 2 display the means for each group. Columns 3 and 4 estimate the linear regression for the primary cost drivers of each group in relation to the SAC of the four major solid organs. Column 5 showcases the Blinder–Oaxaca decomposition, assigning a dollar value to the explained differences. The "Difference in Means" in Column 5 represents the explained variation in dollar amount,$[Mean(X_{high}) - Mean(X_{low})] * \beta_{high}$, while the "Difference in Coefficients" in Column 6 represents the unexplained portion of the variation $[\beta_{high} - \beta_{lo}] * Mean(X_{low})$. The "Total Difference" in Column 7 is the sum of the explained and unexplained variations. See Appendix A for full variable definitions. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A - Kidney	OPO Averages		Regression Coefficents		Blinder–Oaxaca Decomposition		
	High Cost OPOs	Low Cost OPOs	High Cost OPOs	Lower Cost OPOs	**Difference In Means ($)**	Difference in Coefficients	Total Difference
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependant Variable - SAC	35,659	27,073					8,586
Direct Cost / Organ	14,824	12,076	0.62***	0.69***	**1,701**	-891	810
Support Personal / Organ	3,426	2,295	1.00***	0.64***	**1,132**	836	1,968
Coordinator Cost / Organ	7,901	5,809	0.43***	0.83***	**891**	-2,332	-1,441
Total Organs Procured	407.33	459.97	-6.35***	-3.70***	**334**	-1,219	-885
Year	4.40	3.59	383***	313***	**309**	248	557
Transplant Centers	4.09	4.86	-307**	84.08	**239**	-1,902	-1,664
Total Assets	17.18	17.40	-1,004**	-443**	**214**	-9,752	-9,538
Public Education Cost / Organ	1,487	884	0.12	1.23***	**71**	-986	-914
Professional Education / Organ	1,581	1,444	0.44***	0.99***	**60**	-794	-735
Percent Non-Viable Organs	0.18	0.19	-2,328	-4,733**	**35**	465	500
Healthcare Wage Index	0.91	0.81	348	878	**33**	-429	-396
Executive Director Pay / Organ	638	630	1.35**	0.76***	**10**	374	384
Tissue Revenue	13.61	12.36	-99.22**	-30.67	**-124**	-847	-972
Procurement Hospitals	30.02	33.86	43.80	-0.52	**-168**	1,501	1,332
DSA Population	15.35	15.49	1,297	-389	**-178**	26,120	25,942
Total Employees	137	176	8.31***	0.44	**-327**	1,389	1,062
Const	1	1	16,450	23,873***	0	-7,424	-7,424
Adjusted R2			0.55	0.81			
Observations			174	175			
Total Explained ($)					**$4,231**		
% of Total Difference					**49%**		

Panel B - Liver							
	OPO Averages		Regression Coefficents		Blinder–Oaxaca Decomposition		
	High Cost OPOs	Low Cost OPOs	High Cost OPOs	Lower Cost OPOs	**Difference In Means ($)**	Difference in Coefficients	Total Difference
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependant Variable - SAC	40,088	27,719					12,369
Direct Cost / Organ	20,116	10,601	0.66***	0.87***	**6,279**	-2,275	4,004
Support Personal / Organ	3,630	2,513	0.85***	0.93***	**945**	-214	730
Coordinator Cost / Organ	7,114	6,703	0.51***	0.94***	**209**	-2,890	-2,681
Total Organs Procured	211.39	198.24	-12.18***	-11.58***	**-160**	-119	-279
Year	4.30	3.69	478***	249***	**294**	848	1,141
Transplant Centers	4.45	4.50	-288***	281**	**16**	-2,564	-2,548
Total Assets	17.28	17.30	-286	-713*	**5**	7,391	7,396
Public Education Cost / Organ	1,488	914	0.49***	0.26	**282**	209	491
Professional Education / Organ	1,669	1,400	0.63***	0.80***	**168**	-251	-83
Percent Non-Viable Organs	0.10	0.13	4,912	-6,368**	**-136**	1,453	1,316
Healthcare Wage Index	0.87	0.85	4,857***	1,875	**125**	2,520	2,645
Executive Director Pay / Organ	647	703	0.79	1.57***	**-45**	-547	-592
Tissue Revenue	13.18	12.79	36.38	-47.68	**14**	1,075	1,089
Procurement Hospitals	30.24	33.64	12.77	-44.52*	**-43**	1,927	1,884
DSA Population	15.39	15.46	1,770*	1,682**	**-120**	1,359	1,239
Total Employees	135	178	4.79*	2.34*	**-207**	437	230
Const	1	1	-8,893	-5,279	0	-3,614	-3,614
Adjusted R2			0.80	0.81			
Observations			174	175			
Total Explained ($)					**$7,625**		
% of Total Difference					**61%**		

Panel C - Heart							
	OPO Averages		Regression Coefficents		Blinder–Oaxaca Decomposition		
	High Cost OPOs	Low Cost OPOs	High Cost OPOs	Lower Cost OPOs	**Difference In Means ($)**	Difference in Coefficients	Total Difference
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependant Variable - SAC	44,328	28,324					16,004
Direct Cost / Organ	23,731	11,216	0.68***	1.01***	**8,549**	-3,626	4,923
Support Personal / Organ	3,931	2,686	1.02***	0.94***	**1,273**	219	1,492
Coordinator Cost / Organ	6,979	6,679	0.94***	1.05***	**283**	-688	-404
Total Organs Procured	84.52	84.33	9.76	-21.63**	**2**	2,647	2,649
Year	4.34	3.65	262**	272**	**181**	-36	145
Transplant Centers	4.37	4.69	90.88	15.46	**-29**	353	324
Total Assets	17.35	17.29	-181	-1,368***	**-11**	20,536	20,525
Public Education Cost / Organ	1,411	936	0.40**	0.62**	**189**	-207	-18
Professional Education / Organ	1,704	1,365	1.04***	1.06***	**352**	-28	324
Percent Non-Viable Organs	0.03	0.05	4,927	-6,820*	**-89**	566	477
Healthcare Wage Index	0.86	0.85	2,070	1,678	**14**	333	347
Executive Director Pay / Organ	694	714	1.49***	0.69*	**-29**	568	539
Tissue Revenue	13.41	12.53	-38.57	-95.21**	**-34**	710	676
Procurement Hospitals	29.31	35.23	-68.02*	-14.67	**403**	-1,880	-1,477
DSA Population	15.38	15.50	-1,207	748	**144**	-30,310	-30,166
Total Employees	153	165	0.61	4.31***	**-8**	-610	-618
Const	1	1	33,984**	17,719	0	16,264	16,264
Adjusted R2			0.84	0.84			
Observations			172	172			
Total Explained ($)					**$11,192**		
% of Total Difference					**70%**		

Panel D - Lung							
	OPO Averages		Regression Coefficents		Blinder–Oaxaca Decomposition		
	High Cost OPOs	Low Cost OPOs	High Cost OPOs	Lower Cost OPOs	**Difference In Means ($)**	Difference in Coefficients	Total Difference
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependant Variable - SAC	47,255	26,847					20,407
Direct Cost / Organ	25,981	9,038	0.84***	0.82***	**14,179**	159	14,338
Support Personal / Organ	4,005	2,436	0.44*	0.94***	**686**	-1,231	-545
Coordinator Cost / Organ	6,948	6,622	0.50***	0.82***	**163**	-2,140	-1,977
Total Organs Procured	85.15	63.50	-31.28**	-15.11	**-677**	-1,027	-1,704
Year	4.17	3.79	568**	234**	**216**	1,266	1,482
Transplant Centers	5.17	3.81	-185.77	291	**-253**	-1,816	-2,069
Total Assets	17.41	17.18	-3498***	-1,506***	**-825**	-34,219	-35,044
Public Education Cost / Organ	1,306	1,039	-0.63	0.22	**-168**	-879	-1,046
Professional Education / Organ	1,420	1,542	0.29	0.92***	**-35**	-970	-1,005
Percent Non-Viable Organs	0.11	0.20	-11,353**	-3,026	**1,068**	-1,681	-613
Healthcare Wage Index	0.87	0.85	1,112	-636	**26**	1,478	1,504
Executive Director Pay / Organ	712	695	-2.25*	0.62	**-39**	-1,990	-2,029
Tissue Revenue	13.42	12.53	233***	-47.81	**209**	3,521	3,730
Procurement Hospitals	33.68	30.41	11.23	-50.18	**37**	1,868	1,904
DSA Population	15.50	15.36	1,103	1,040	**159**	974	1,132
Total Employees	146	169	-0.55	3.67**	**13**	-715	-702
Const	1	1	63,987**	20,798	0	43,190	43,190
Adjusted R2			0.74	0.77			
Observations			173	174			
Total Explained ($)					**$14,757**		
% of Total Difference					**72%**		

Declaration of generative AI and AI-assisted technologies in the writing process.

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