

Administrative Burden and Consolidation in Health Care: Evidence from Medicare Contractor Transitions

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The US health care system is rife with administrative burdens, such as those imposed by claim denials. However, little is known about the causal effects of these burdens on providers. Using exogenous changes to the jurisdictions of Medicare Administrative Contractors, I show that administrative burdens cause providers to adopt cost-saving technologies, bill more aggressively, and consolidate into larger practices. Despite an increase in denial rates following a change in contractors, Medicare spending increases as a result of providers' endogenous responses. These results are explained by a theoretical model of provider investment in billing effort and technology. I estimate this model to show that these investment costs amount to \$31 billion per year and that increasing administrative burdens lowers provider profits by 2-3% while raising Medicare spending, making both parties worse off.

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1 Introduction

A quarter of the \$4 trillion of annual health care spending in the United States goes to administrative costs (Sahni et al., 2021; Himmelstein et al., 2020). The consequences of these large administrative burdens are theoretically ambiguous. On the one hand, they could achieve their purpose of reducing total health care spending by discouraging the use of medically unnecessary or low-value services. On the other, they could represent a pure waste of effort and resources or contribute to rising consolidation in the health care sector by increasing the fixed costs of treating patients. In this paper, I provide novel empirical evidence on the consequences of administrative burdens, finding that they lead to increased consolidation and higher health care spending.

To identify the impact of administrative burdens on provider behavior and market outcomes, I use changes in claim denial rates resulting from the decentralized administrative structure of Medicare. While federally funded, Traditional Medicare is administered regionally by privately-owned companies called Medicare Administrative Contractors, which vary widely in the share of claims they deny. Over time, there have been exogenous changes in the assignment of jurisdictions to administrators, which allows me to identify each contractor's causal effect on denials and assess how providers react to changes in the burdens they face. This variation allows me to assess the responses of the same providers and the same patients to a new administrative regime and thus provide the first evidence on how entire health care markets react to changes in the burdens they face from claim denials.

Studying the impact of exogenous changes in claim denials provides a unique opportunity to understand the broader consequences of administrative costs. Not only are claim denials very costly to health care providers (Dunn et al., 2021), they also represent a breakdown of the larger, very complicated billing system that imposes large burdens on the health care sector. Despite the billions of dollars invested each year in administrative technologies like electronic health records, billing software, and specialized staff, up to \$54 billion worth of claims are denied each year (Gottlieb et al., 2018). As such, claim denials serve as useful proxies for the much broader trillion-dollar health care administration apparatus (Sahni et al., 2021). The responses of providers to changes in denial rates induced by changes in Medicare administrators can be informative about the relationship between this wider system and the administrative burdens imposed by insurers.

For my empirical analysis, I use variation in administrative burdens and claim denial rates induced by the government's consolidation of Medicare administrative jurisdictions over time, with the number of jurisdictions falling from 58 to 12 during my sample period. This consolidation has resulted in providers and patients being exposed to different administrators and, therefore, different administrative burdens: comparing the denial rate of jurisdictions as they transition between different administrators, I find large differences across contractors in their propensities

to deny claims. The difference between the lowest- and highest-denial administrators is over 5 percentage points, compared to a mean denial rate of 6.4%.

After identifying each contractor's causal effect on denial rates, I then show how health care providers respond to changes in administrative burdens. I find that following an increase in administrative burden, providers increase their adoption of electronic health records and increase the charges they submit to Medicare. Furthermore, I find that 1% of practices exit the market, with this result being driven by single-provider firms. This leads to a 1.1% increase in the size of the average practice remaining after the transition and the share of providers in solo practice falling by 1.2%. I find little evidence of improved care: the use of low-value care is largely unresponsive to claim denials and transitions between administrators have no discernable impact on beneficiary mortality. Finally, despite administrators denying 20% more claims after transitions to higher-denial contractors, providers' responses to the increased burden result in a 4.5% *increase* in total Medicare spending. Although payers typically intend for administrative burdens to curtail health care spending, I find they have the opposite effect.

I explain these counterintuitive results with a model of providers choosing the profit-maximizing level of investment in billing technology meant to increase charges and avoid denials. When faced with a greater burden, medical practices earn higher returns from adopting billing software, hiring administrative staff, and investing more time in administrative tasks. These investments allow firms to bill Medicare for more charges and better avoid claim denials. My empirical results show that this response outweighs the increase in denials, resulting in a net increase in Medicare spending. With Medicare spending more and practices earning less due to their higher costs, increased administrative burdens ultimately make both parties worse off. Furthermore, the model explains the exit and consolidation observed in the data as coming from the high fixed costs of billing technology: small practices do not have a large enough patient volume to justify making the large investments required to handle complex billing rules.

My findings support widespread but heretofore empirically unsubstantiated worries about an “administrative arms race” between insurers and providers where insurers impose burdens and require more complex billing in an attempt to reduce payments to providers, which providers respond to by investing in more administrative architecture to claw back this revenue (Cutler, 2018). This in turn leads insurers to impose even higher burdens that providers then attempt to circumvent—a race to the bottom that makes both insurers and providers worse off.

Estimating a parameterized version of my theoretical model, I find billing costs are \$2,400 per provider per month, or \$30.7 billion in total billing costs in 2017. Given that these investments are induced by administrative burdens that lead to higher Medicare spending, lower profits for providers, and greater consolidation, my results show that administrative burdens are bad for insurers, providers, and patients and do not serve as efficient frictions to prevent fraud and waste. In short, administrative burdens are too high.

This study contributes to a burgeoning literature on administrative costs in the health care sector. That the burdens are high is well established: the US spends much more on administrative costs than other rich countries. For example, the US has 76% more non-clinical health care workers per capita than Canada, and US physicians spend 69% more of their time on administrative tasks than Canadian ones (Pozen and Cutler, 2010). Physicians spend at least 7 hours per week on administrative tasks (Remler et al., 2000; Sinsky et al., 2016), while these tasks consume over a third of nurse time (Hendrich et al., 2008; Casalino et al., 2009). Hospitals even have 50% more administrative workers than beds, and there are 2.2 administrative workers for every office-based physician (Cutler and Ly, 2011). My estimate of the total costs of billing administration of over three-quarters of a trillion dollars further illustrate this high cost.

Although much of this administrative burden is certainly wasteful—Sahni et al. (2021) argue \$265 billion per year could be saved by reducing unnecessary administrative costs—which administrative barriers are worthwhile is an open question (Chernew and Mintz, 2021). One hope for administrative barriers is that they act as efficient ordeals, screening out low-value uses of expensive procedures (Nichols and Zeckhauser, 1982; Zeckhauser, 2021). Previous research has often supported this view, finding that some administrative barriers can result in lower health care spending without adversely impacting patient health. For example, prior authorization can be used to steer patients to lower cost prescription medications (Brot-Goldberg et al., 2022) or to combat fraud (Eliason et al., 2021); audits can reduce the provision of medically unnecessary care (Shi, 2022) and upcoding (Ganju et al., 2022); and real-time claim denials can induce pharmacies to dispense cheaper medications (Macambira et al., 2022). In contrast to the narrowly tailored and highly salient administrative burdens studied by previous research, however, my results show that claim denials increase overall health care spending as providers invest in billing technology to circumvent this burden.

In this way, my results align with a smaller literature that highlights the negative consequences of administrative burdens beyond their potential to waste scarce resources. Perhaps most related, Dunn et al. (2021) find that providers respond to high Medicaid denial rates by declining to accept Medicaid patients. In different contexts, multiple studies have found administrative ordeals limit enrollment in health and social insurance programs as well (Shepard and Wagner, 2021; Homonoff and Somerville, 2021; Finkelstein and Notowidigdo, 2019; Deshpande and Li, 2019). My findings of greater exit, consolidation, and spending add to the growing evidence of the negative consequences of administrative burdens.

My research stands apart from existing work on administrative burdens in two key ways. First, this paper studies plausibly exogenous changes in administrative burden, whereas most existing research has focused on cross-sectional differences across space (e.g. Dunn et al., 2021; Shi, 2022; Ganju et al., 2022) because payers rarely alter the administrative costs they impose in a manner large enough to discern a response from providers and providers are rarely assigned

to new payers or administrators exogenously like they are in my setting. Second, the shocks to administrative burden that I study are large and felt by nearly all providers. While well-executed studies of more narrowly tailored administrative burdens like prior authorization (Eliason et al., 2021; Brot-Goldberg et al., 2022) and automatic claim adjudication (Macambira et al., 2022) are crucial for understanding how providers react to well-targeted burdens, they have little to say about the broader implications of the high levels of administrative burden endemic to the health care system. By contrast, all medical providers engage in billing and face the threat of claim denials. Furthermore, the administrative burdens imposed by Medicare are especially likely to reflect the broader consequences of administrative costs because Medicare has such a large influence on the health care sector. Traditional Medicare represents the largest single insurance plan in the country, insuring almost 40 million people (CMS, 2022) and being accepted by 99% of non-pediatric physicians (Ochieng et al., 2020). In light of Medicare's outsize influence on the health care system, responses to the administrative burdens it imposes are more likely to reflect the most important consequences of administrative costs—such as changes in market structure—than less widespread burdens.

More narrowly, this paper also advances our understanding of the impact of Medicare's administrative structure on the health care system. A few studies have noted the high level of variation in posted rules about coverage across Medicare Administrative Contractors (Foote and Town, 2007; Levinson, 2014a), while others have highlighted discrete cases where differences in these rules may lead to differences in medical practice (Wilk et al., 2018; Carlson et al., 2009; Foote et al., 2008). Although League (2022) shows that differences in administrator policies greatly impact the adoption of new medical procedures, this study is the first to document the large differences in overall stringency of Medicare contractors and the consequences of these differences.

My research also provides new evidence on the drivers of consolidation in the health care industry. Although many economists have emphasized that consolidation leads to higher prices and profitability for providers, providers and their defenders often contend that policy changes are increasing costs in a way that necessitates consolidation (Smidt, 2015; Daly, 2018; Gold, 2021). Adoption of expensive billing software, for example, has very high fixed costs that only large practices can bear easily (Fleming et al., 2011; Dranove et al., 2014; Bronsoler et al., 2022), and increased scrutiny of claims by insurers may necessitate hiring additional coding staff, which also may not be feasible for small practices. A large literature has shown the negative consequences of this consolidation, including higher prices (Gaynor and Vogt, 2003; Dafny, 2009; Gowrisankaran et al., 2015; Cooper et al., 2019), less access to care (Town et al., 2006, 2007), lower wages (Prager and Schmitt, 2021), and few improvements in health outcomes (Cutler et al., 2010; Gaynor et al., 2013; Bloom et al., 2015; Eliason et al., 2020). Because I find that administrative burdens are a precursor to consolidation, reducing these burdens for providers will have ancillary benefits for

the entire health care system.

This relates closely to the drivers of consolidation more broadly, and in particular how regulations can increase fixed costs and alter market structure. Regulation has been found to increase concentration in markets as diverse as cement (Ryan, 2012; Fowlie et al., 2016), abortion (Beauchamp, 2015), hotels (Suzuki, 2013), pharmaceuticals (Thomas, 1990), and television (Nishida and Gil, 2014). Furthermore, cross-industry comparisons generally corroborate these results, with regulations serving to reduce the number of firms and increase their size (Klapper et al., 2006; Bailey and Thomas, 2017). Reducing competition is often an unintended consequence of regulation, but incumbent firms often encourage regulation in order to insulate themselves from competition (Stigler, 1971). I provide novel evidence that regulation also disproportionately favors large firms in health care markets as a result of the administrative burden it imposes on providers.

The remainder of this paper is structured as follows. Section 2 describes the health care billing process and provides background on Medicare Administrative Contractors. Section 3 describes the Medicare claims and other sources of data I use in this paper. Section 4 presents evidence that Medicare contractors differ in the administrative burdens they impose on providers and lays out my empirical strategy for using this variation to understand how providers respond to increases in administrative burden. Section 5 presents a theoretical model of investment in billing technology that generates empirical predictions tested in Section 6. Section 7 presents estimates of a parameterized version of my theoretical model. Section 8 concludes.

2 Institutional Context

2.1 Medical Billing Process

The medical billing process is characterized by complexity: multiple insurers with different billing rules, multiple coding systems and forms, and multiple administrative requirements that can be opaque and arbitrary. Figure 1 briefly sketches the costs incurred in a medical practice’s billing cycle and the ways that firms can invest in billing technology to overcome administrative burdens. The figure (and my description here) abstract from many sources of administrative costs, including those required for checking a patient’s insurance status and collecting payment from patients, along with the difficulties that come from having to bill multiple insurers with diverse requirements. The first step of the cycle requires checking that the care the provider plans to render accords with all the known requirements and sometimes getting explicit permission from insurers or patients before then engaging in extensive documentation of the encounter using a variety of technologies, like electronic health records, voice-to-text technology, or employing staff members called scribes to record these notes. These notes must then get translated

Figure 1: Billing Cycle



Notes: Author's description of a medical practice's billing cycle and the investments in billing technology that can improve the efficiency of the process. Template for graphic is from <https://slidesgo.com/>.

into a claim that will be sent to the insurer to request payment. This is also usually done by administrative staff (called coders), often with the assistance of billing software. Once the claim is submitted the insurer reviews the claim and decides to either pay or reject it for any number of reasons, including patient enrollment status, medical necessity requirements, or more technical administrative reasons. If the claim is rejected, it begins what is essentially an onerous revise and resubmit process that may not ever result in payment. Finally as this process plays out, the administrative staff of the practice try to learn about what works and what doesn't for this one insurer and this one type of patient and enact policies and programs that attempt to avoid denials in the future. This involves educating providers about the billing rules, performing utilization review to identify potential areas of improvement, and implementing case management programs to better guide care throughout the process.

As this process makes clear, claim denials are costly. This is true both because they represent forgone revenue to the practice as well as because they require additional effort on the part of administrative staff to resolve.¹ More fundamentally, though, claim denials are an excellent proxy for the broader administrative costs imposed by the onerous and complicated billing system we have in health care. The entire billing cycle is geared toward preventing claim denials, meaning that they represent a breakdown of the whole process.

Throughout the billing cycle, providers can make a number of investments to avoid these

¹Dunn et al. (2021) estimate that foregone revenue represents two-thirds of the cost of having a claim denied by Medicare while resubmission costs account for the remaining third.

costly claim denials. These investments can occur at various points in the process and include hiring staff to take notes, submit claims, or review outcomes as well as purchasing IT infrastructure that does the same, like electronic health records and billing software. I refer to these various investments collectively as billing technology, and, as I'll show below, providers increase this investment in response to increased denials.

2.2 Medicare Administrative Contractors

Traditional Medicare is often thought of as a monolithic, federally-run insurance program (NBPAS, 2021).² But while the government bears all actuarial risk and determines the vast majority of Medicare policy, the day-to-day administrative operations are performed by private contractors called Medicare Administrative Contractors, or MACs, who have distinct regional jurisdictions in which they operate. The administrative tasks performed by these contractors include processing medical claims and prior authorization requests, enrolling health care providers in the Medicare program, and determining the conditions under which Medicare will reimburse providers for various health care services.

Although statutory guidelines dictate the type of medical services Medicare is intended to pay for, administrators have wide discretion over how to implement these broad standards—they must avoid payment for services that “are not reasonable and necessary for the diagnosis or treatment of illness or injury or to improve the functioning of a malformed body member” (Social Security Act, 1965a). While there are a few examples of the federal government providing more specific guidance on whether certain services meet this standard, in general, these determinations are left to the local contractors.³ And while some of these coverage rules are stark declarations that a given service will not be reimbursed in any circumstance, it is much more common that these rules delineate the circumstances under which the service will be reimbursed, including the allowed frequency or place of service, permissible indications, or billing or documentation rules. These rules are disseminated to health care providers through direct communication and provider education programs as well as through the administrator posting documents called

²Event Medicare's own website says, “Original Medicare is coverage managed by the federal government” (Medicare.gov, 2022).

³The federal government can specify coverage rules legislatively or administratively. Legislative rules must go through the normal legislative process and so are uncommon. A rare example of this is regulation on the allowed frequency of various screenings, including mammography and colonoscopy (Social Security Act, 1965b). More common are administratively-created rules. Analogous to the Local Coverage Determinations (LCDs) issued by the local contractors are the National Coverage Determinations (NCDs) issued by the Centers for Medicare and Medicaid Services. NCDs supersede LCDs and are made when “the service is the subject of substantial controversy” surrounding the item or service (Centers for Medicare and Medicaid Services, 2003). One prominent recent example of this is the NCD limiting coverage of the controversial Alzheimer’s drug Aduhelm (Centers for Medicare and Medicaid Services, 2022).

Local Coverage Determinations and Articles, which are posted online.⁴ These coverage rules are generally enforced automatically by checking claims against claim edits, formalized billing rules built into the administrator's claims processing apparatus. Claims are also sometimes reviewed manually by administrators, generally after being resubmitted by a provider after failing one of the automatic checks.

Administrators are contracted to provide administrative services for distinct regional jurisdictions determined by the Centers for Medicare and Medicaid Services (CMS). The contract for each jurisdiction is assigned to a contractor using a procurement auction run by the federal government in which bids are scored based on quality and cost. Awarded contracts have a cost-plus structure, meaning that contractors are reimbursed for their costs plus a small bonus incentive contingent on good performance. Importantly, contractors bear no actuarial risk and so have no direct financial incentive to deny claims and impose burdens to restrain costs. In fact, contractors are often seen as generally prioritizing claims processing efficiency over implementing programs to reduce overall spending, including fraud-detection programs (Sparrow, 2000).⁵

Across jurisdictions, the coverage rules implemented by each administrator often vary widely. For example, an inspector general report found that in 2011 35% of procedures were subject to Local Coverage Determinations only in some jurisdictions, while 59% of procedures were subject to an LCD issued by at least one administrator (Levinson, 2014a). These differences in rules may stem from the large differences in medical practice across jurisdictions, with administrators of some areas reacting to perceived overbilling or accommodating local innovations in their jurisdictions (MedPAC, 2018). However, this variation also likely stems from the idiosyncratic tastes of the administrators and persistent differences in corporate culture or taste for imposition of administrative burdens. To that end, while the use of multiple administrators can encourage more locally tailored coverage rules, the current differentiation of coverage rules is commonly seen as indicative of inefficiency (Levinson, 2014a).

In response to the apparently arbitrary differences in coverage rules across jurisdictions, the federal government reduced the number of contracts and increase their size (Levinson, 2014a). At the beginning of my sample, there were 26 active administrative companies operating in jurisdictions that sometimes spanned state borders (e.g., the Washington, DC area) or were strict subsets of states (e.g., New York). Since the mid-2000s, CMS has gradually reduced the number of jurisdictions, combining multiple states to be under the same contracted jurisdiction. Figure 2 shows that the number of companies administering Traditional Medicare has decreased significantly over the last two decades as CMS reduced the number of jurisdictions from 58 in

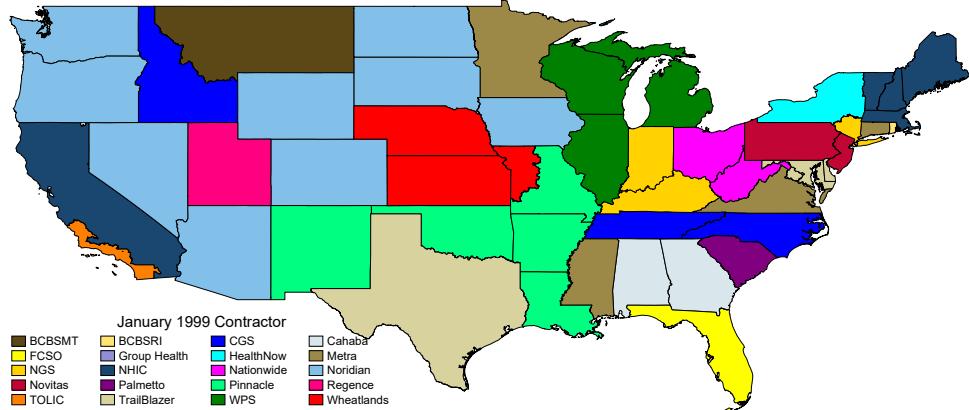
⁴Current Local Coverage Determinations can be found at <https://www.cms.gov/medicare-coverage-database/>.

⁵More details on these contracts are available in Appendix A.

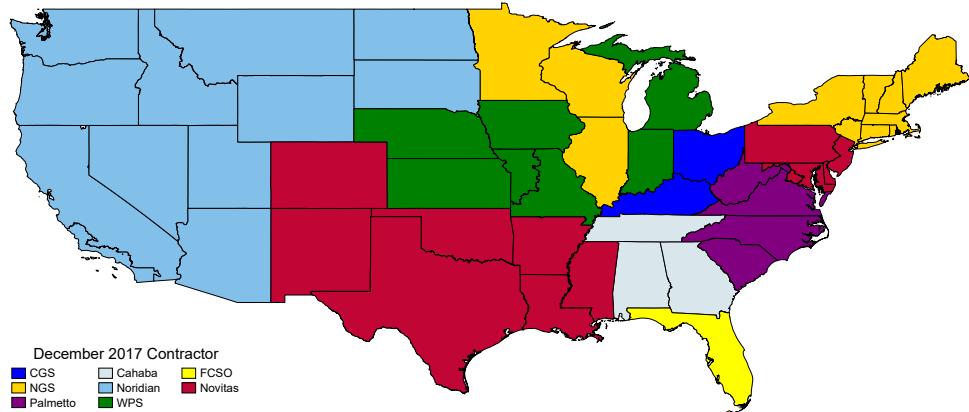
the early 2000s to 12 today.⁶

Figure 2: Contractor Changes from 1999-2017

(a) Contractors in 1999



(b) Contractors in 2017



Notes: Each panel reports the administrative company responsible for processing Medicare Part B claims in each jurisdiction of the continental United States in the relevant month. Panel (a) reports this data for January 1999 while panel (b) reports data for December 2017.

When a jurisdiction changes Medicare contractors, the coverage rules are updated to harmonize coverage for all providers whose claims are processed by the administrator (GAO, 2015). This means that the recent consolidation in jurisdictions has led to many changes in the coverage rules faced by providers. I observe 59 areas transitioning between contractors during my sample, and these transitions are likely exogenous to the previous denial rates in the local jurisdictions. The original jurisdictional boundaries were set in 1960s and were primarily determined by existing health insurers' ability to quickly implement the then-new Medicare program (Mennemeyer,

⁶At the beginning of my sample, Medicare Part B claims were processed by entities called “carriers” and Part A claims were processed by “fiscal intermediaries.” In addition to consolidating the regional jurisdictions these entities administered, CMS also combined the functions of processing Part A and B claims to be performed by a single contractor for a jurisdiction, newly called a Medicare Administrative Contractor. In this paper, I consider only Part B physician services and so refer to carriers and Medicare Administrative Contractors interchangeably.

1984). The recently consolidated jurisdictions were “designed to reasonably balance distributions of FFS beneficiaries, practitioners and claims volumes” rather than to match jurisdictions with contractors that would impact claim denials in a certain way (CMS, 2005). This indicates that the presence of an administrator in a jurisdiction was not determined by the expected impact of that administrator on the denial rate, so examining how the denial rates changes following a change in administrator can plausibly recover the causal effect of the administrator on denials.

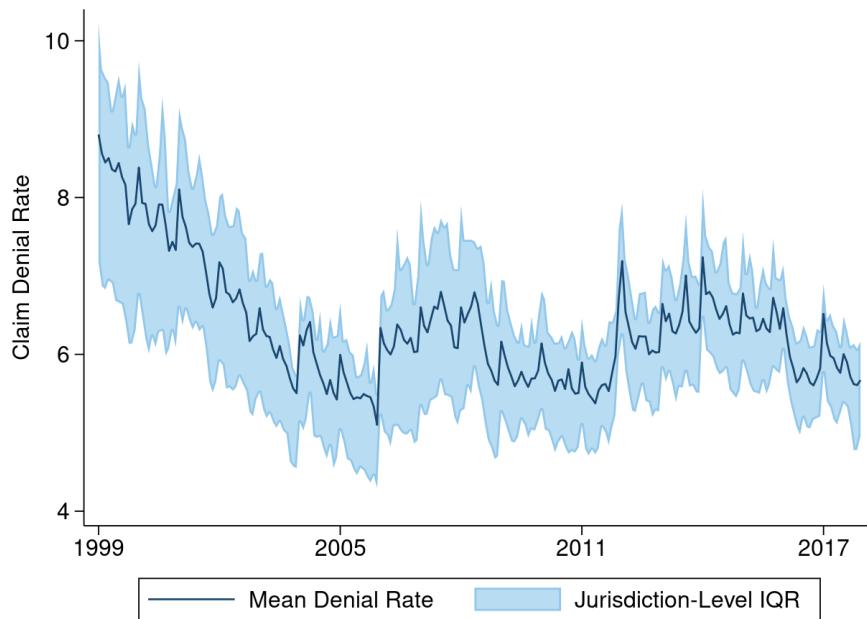
3 Data

The primary data used for this project come from a 20% random sample of Medicare claims for physician services (called the carrier file) from 1999–2017. This data set includes encounter-level information on patient diagnoses, procedures performed, payments made by the patient and insurer, and various claims processing information including the contractor that processed it and whether it was denied. These data represent fully adjudicated claims, meaning that I do not observe claims that are initially denied before being successfully appealed by the provider. This means that the advantage of my data set comes from its size and scope—Medicare is the single largest insurer in the country and other insurers often follow its actions (Clemens and Gottlieb, 2017)—rather than the detail provided on the back-and-forth between providers and insurers (Dunn et al., 2021) or the reasons for denial (Schwartz et al., 2022). Furthermore, using Medicare claims data allows me to identify the administrative contractor processing the claim, which then allows me to identify the responses of providers to being exposed to contractors with different denial rates.

Another important piece of information contained in the Medicare claims data is the Taxpayer Identification Number (TIN) of the entity billing Medicare. This allows me to construct firm-level information such as the number of providers in the firm and whether the firm is active. Although using TINs to define firms is common in the literature on horizontal and vertical integration in health care (e.g. Capps et al., 2018; Austin and Baker, 2015; Welch et al., 2013), this definition has well-known measurement error.⁷ Because TINs are assigned by the Internal Revenue Service and are reported on claims for tax compliance purposes, rather than being assigned or reported by Medicare Administrative Contractors, I have no reason to believe that this measurement error would differ by contractor or be correlated with the timing of contractor transitions. I construct firm-month level data on the number of unique providers billing under the same TIN in the same jurisdiction, as well as firm-month-level data on denials, charges, and payments. Finally, I also construct jurisdiction-month-level counts of the number of active TINs.

⁷In particular, large group practices may bill under multiple TINs, inflating the apparent number of firms and decreasing their apparent size. Furthermore, when a practice is acquired or merges with another practice or with a hospital, providers may continue to bill under the same TIN.

Figure 3: Denial Rate Over Time



Notes: Jurisdiction-month-level mean share of claims denied along with the denial rates of the 25th and 75th quintile jurisdictions.

I also use state-year-level data from the Office of the National Coordinator for Health Information Technology on physicians' adoption of electronic health record (EHR) technology to understand how administrative costs relate to EHR adoption. These data report the share of office-based physicians that have adopted basic EHR technology, defined as computerized systems that record clinician notes and orders, patient demographics and medication and problem lists, and allow for the viewing of laboratory and imaging results. These data are available from 2010–2015, a period of rapid growth in the adoption of this technology.

Table 1 reports summary statistics for my data at the jurisdiction-month level, including the mean and standard deviation of the outcomes and covariates used in the analysis. Note that the mean claim denial rate is 6.4%, indicating that roughly 1 in 15 claims is ultimately unpaid. This estimate is in line with the finding by (Dunn et al., 2021) that 7.3% of Medicare claims were initially denied in the data they use from 2013–2015. Note that there is significant variation across jurisdictions in this rate of denials: the standard deviation is 1.7, or 27% of the mean.

Much of this variation in denial rates comes from change over time. As shown in Figure 3, the denial rate fell rapidly over the first few years of my sample before stabilizing around 6%. The variation across jurisdictions also fell modestly over this time, with the inter-quartile range falling from over 3 to less than 1.5.

Table 2 reports summary statistics on each Medicare Administrative Contractor in my data. In the cross-section, there is wide variation in the denial rates across contractors, ranging from

Table 1: Summary Statistics

	Mean	Std. Dev.
<i>Outcomes</i>		
Denial Rate	6.360	1.727
Charges (per beneficiary)	601.5	249.6
Payments (per beneficiary)	221.4	72.06
Percentage with EHR	43.00	14.86
Providers per Firm	3.885	1.160
Active Firms	4555	4473
<i>Controls</i>		
Beneficiaries (thousands)	114.4	99.51
Average Age	71.67	1.237
Dual-Eligible Percentage	17.93	6.718
Percentage White	84.24	13.76
Percentage Black	8.723	10.59
Percentage Other Race	6.529	10.39
Percentage with ESRD	1.007	4.388
Percentage Disabled	16.13	3.974
Observations	12,996	

Notes: Percentage of providers with electronic health records (EHR) is defined at the state-year level from 2010-2015. Providers per firm is the average number of unique providers in a jurisdiction billing under the same tax identification number. Active firms is the number of unique tax identification numbers under which a claim is submitted. Both firm-related variables are reported at the jurisdiction-month level and defined starting in 2006. All other variables are reported at the jurisdiction-month level from 1999-2017. ESRD and disabled percentages report the share of Medicare beneficiaries eligible for Medicare due to end-stage renal disease or disability.

Table 2: Contractor Summary Statistics

Contractor	Denial Rate	Exit Year	Transition Source	Transition Destination	Obs.
Metra	11.03	2000	4	0	80
Group Health	10.84	2008	1	0	114
BCBSRI	9.04	2003	1	0	60
TOLIC	7.73	2000	1	0	22
Regence	7.36	2005	1	0	83
Nationwide	6.94	2002	2	0	82
HealthNow	6.93	2008	1	0	116
Noridian	6.87	-	4	7	2602
CGS	6.54	-	3	2	591
TrailBlazer	6.50	2012	9	4	918
NGS	6.48	-	3	12	1404
Pinnacle	6.40	2012	6	1	719
FCSO	6.15	-	1	2	430
Novitas	6.14	-	1	12	1236
NHIC	6.11	2013	7	2	971
Cahaba	6.00	2018	1	2	702
BCBSMT	5.96	2006	1	0	94
Palmetto	5.85	-	5	8	931
Triple-S	5.73	2009	1	0	121
WPS	5.58	-	3	7	1393
Wheatlands	4.90	2008	3	0	327

Notes: Denial rate is the percentage of claims denied in jurisdictions administered by the contractor from 1999-2017. Exit year reports the last year the contractor administered any jurisdiction and is missing if the contractor is currently administering at least one jurisdiction. Transition source and destination report the number of jurisdictions that transition from or to this contractor from a different contractor from 1999-2017. Observation count is given by the number of jurisdiction-months the contractor administered from 1999-2017.

less than 5% for Wheatlands to over 11% for Metra. As will be critical for my empirical strategy, every contractor has at least one jurisdiction transition to or from being administered by that company, meaning that I can identify the causal effect of every administrator.

4 Empirical Strategy

To understand how providers respond to administrative burden, I will compare the outcomes in jurisdictions that transition between administrative contractors that impose different levels of burden. For this to be a valid empirical strategy, two main conditions must be met. First, these transitions must cause the level of administrative burden imposed on providers to change. Second, any changes observed in the outcomes I study must be attributable these changes. As

discussed in Section 2, the exogeneity needed to satisfy the second requirement is likely met due to the institutional process that consolidated administrative jurisdictions. Therefore in this section, I will focus on presenting evidence that administrative contractors differ in the levels of administrative burden they impose while also describing the empirical strategy I use to assess the responses of providers to administrator transitions more broadly.

The jurisdictions that Medicare Administrative Contractors administer are determined by government regulation, and the number of these regions has decreased over time, from 58 in 1999 to 12 in 2017. This jurisdictional consolidation induced exogenous variation in the areas administered by each contractor, with 59 jurisdictions transitioning between administrative companies during my sample. Using a two-way fixed effects model, I use this variation to identify the causal effect of each contractor on the administrative burden faced by providers, holding constant time-invariant characteristics of each jurisdiction as well as national trends. I validate this model by examining the window immediately surrounding transitions of jurisdictions between contractors using dynamic difference-in-differences methods. The model I use to identify the impact of each administrator is

$$(1) \quad Y_{jmt} = \mu_m + \Gamma X_{jt} + \alpha_{0j} + \alpha_{1j}t + \eta_t + \varepsilon_{jmt},$$

where Y_{jmt} is the share of claims denied in jurisdiction j administered by Medicare Administrative Contractor m in month t ,⁸ X_{jt} is a vector of observable jurisdiction-level beneficiary characteristics,⁹ and γ_m , α_{0j} , and η_t are administrator, jurisdiction, and time period fixed effects, respectively. Including $\alpha_{1j}t$ allows for jurisdiction-specific time trends,¹⁰ and ε_{jmt} is a jurisdiction-contractor-month specific error term, which I allow to be arbitrarily correlated within a jurisdiction over time and across jurisdictions within each month. γ_m is the object of interest: the impact of each contractor on the denial rate.

This empirical strategy isolates differences in denial rates attributable to differences in the administrator rather than other drivers of administrative burden that may vary geographically or over time. Because jurisdictions transition between different administrators, I am able to compare the denial rates for the same beneficiary population and provider community. Given the wide geographic variation in both the values and health status of the patient population as well as the beliefs, norms, and culture of health care providers (Fisher et al., 2003a,b; Finkelstein et al., 2016), these transitions are necessary to identify the contribution of each contractor to

⁸In Appendix B, I use alternative measures of administrative burden including claim line denial rates and the share of charges denied as the dependent variable, showing that my results are robust to these alternative definitions and indicating that I am assessing a robust measure of administrative burden.

⁹These include a quadratic function of the number of enrollees, the average age of enrollees, the shares of enrollees that are eligible due to end-stage renal disease, eligible due to disability, white, black, and eligible for Medicaid.

¹⁰In Appendix C, I show that the estimated fixed effects are robust to a more or less flexible jurisdiction-specific time trend.

differences in denial rates.

To validate that I am capturing a causal effect of each administrative company rather than misattributing the impact of residual trends, I examine transition events between contractors with high or low estimated effects on denials. To do this, I follow Cengiz et al. (2019) in creating a stacked data set to construct appropriate control groups for each transition. To implement this method, I create separate data sets for each transition w (for wave) consisting of the jurisdiction that transitions at time g and control jurisdictions that do not also experience a transition during the event window, which I generally define to be 18 months before and after transition.¹¹ Each of these data sets is appended (or “stacked”) such that each transitioning jurisdiction appears once while each jurisdiction may appear as a control multiple times (although with different time values). I then estimate

(2)

$$Y_{jtw} = \sum_{e=-K}^{-2} \beta_e T_{jtw}(e) + \sum_{e=0}^L \beta_e T_{jtw}(e) + \sum_{e=-K}^{-2} \delta_e T_{jtw}(e) \times U_w + \sum_{e=0}^L \delta_e T_{jtw}(e) \times U_w + \Gamma X_{jtw} + \alpha_{jw} + \eta_{tw} + \varepsilon_{jtw},$$

where K and L give the size of the treatment window, $T_{jtw}(e)$ is an indicator for being the transitioning jurisdiction e months from transition (where e denotes event time: $e \equiv t - w$), U_w is an indicator for whether the transition is from a contractor with a lower estimated effect on denials to a higher one, α_{jw} and α_{tw} are jurisdiction-by-wave and time-by-wave fixed effects. These fixed effects account for the fact that control observations may appear more than once in this stacked data set. δ_e is the object of interest and reports the differential change in denial rates in jurisdictions that transition to higher-denial administrators relative to lower-denial administrators. This comparison is relative to jurisdictions that do not change administrators during the event window and therefore can be thought of as a dynamic triple-differences specification. The key identifying assumption is that the only differential change between high-denial and low-denial contractors at the time of transition that would impact the denial rate is the transition itself. This would be violated if, for example, low-denial rate jurisdictions whose denial rates would naturally rise due to reversion to the mean were disproportionately assigned to high-denial administrators. Given the exogenous nature of the assignment of administrators to jurisdictions, I have no reason to believe this is the case.

Similarly, I estimate the transition dynamics regardless of the administrators between which

¹¹In unreported robustness checks, I have also verified that my results are robust to alternative treatment windows as well as limiting the control group to only jurisdictions that are not administered by either of the contractors involved in the transition of the jurisdiction in question as well as limiting my analysis to the 41 jurisdiction transitions that correspond to the creation of new Medicare Administrative Contractor jurisdictions rather than also including transitions that occur when an incumbent administrator loses a potentially unchanging contract.

the jurisdiction is transitioning:

$$(3) \quad Y_{jtw} = \sum_{e=-K}^{-2} \beta_e T_{jtw}(e) + \sum_{e=0}^L \beta_e T_{jtw}(e) + \Gamma X_{jtw} + \alpha_{jw} + \eta_{tw} + \varepsilon_{jtw}.$$

This equation is also estimated using stacked regression, but rather than comparing transitions between high- and low-denial administrators in a triple-difference framework, compares jurisdictions that transition to any administrator to those that do not transition at the same time. The identification of β_e relies primarily on the standard difference-in-differences assumption that any changes in the denial rate for jurisdictions that change administrators, relative to changes in the denial rate elsewhere, can be attributed to the transition.

Using the stacked regression method is particularly appealing in this setting because by assuming that any dynamic treatment effects stabilize at some point after a transition (at most K months prior to the next transition), I am able to extend the method beyond the context considered by Cengiz et al. (2019) to allow for a unit to be treated multiple times. Specifically, I can allow jurisdictions to transition between contractors multiple times.

In addition to understanding how transitions between Medicare contractors affect administrative burden, I can employ the same estimation strategy to understand how provider behavior and market outcomes change following contractor transitions. In Section 6, I estimate the same equations with various other outcomes, including Medicare spending and charges as well as measures of market concentration. For these outcomes, the identification assumption is that the only differential change experienced by providers transitioning to a higher-denial administrator is an increase in the administrative burden they face.

Due to the limited time period for which I have data on EHR adoption, I must slightly alter my estimation strategy for that part of my analysis. For this, I employ closely related standard difference-in-differences techniques to compare the rate of adoption following transitions of jurisdictions to higher- or lower-denial administrators. In particular, I estimate

$$(4) \quad Y_{sy} = \sum_{e=-3}^{-2} \beta_e T_{sy}(e) + \sum_{e=0}^4 \beta_e T_{jtw}(e) + \sum_{e=-3}^{-2} \delta_e T_{sy}(e) \times U_s + \sum_{e=0}^4 \delta_e T_{jtw}(e) \times U_s + \alpha_s + \alpha_y + \varepsilon_{sy}$$

using the traditional two-way fixed effects estimator (i.e. not stacked regression), where Y_{sy} is the share of physicians having adopted basic EHR technology in state s in year y . To address concerns about aggregation across different waves of treatment (Callaway and Sant'Anna, 2021; Goodman-Bacon, 2021), I present estimates for transitions that occur in 2011, 2012, and 2013 separately as well.

4.1 Effect of Contractor Transitions on Administrative Burden

Using the methods described in the previous subsection, I find that Medicare Administrative Contractors vary widely in the administrative burdens they impose and their causal effects on denial rates. Table 3 gives the estimated effect of each contractor on the share of claims denied.¹² These estimates indicate a wide range of effects, with the administrator that denies the most claims (Metra) denying 5.4 percentage points more claims than that which denies the least (TOLIC). This represents a substantial difference given the mean denial rate is only 6.4%. Furthermore, the causal differences are not perfectly reflected in the raw denial rates of each contractor reported in Table 2, indicating important differences over time and across jurisdictions in the way providers bill regardless of the administrator processing the claims. A joint significance test of the equality of all of the coefficients reported in Table 3 yields an F-statistic of 278, indicating statistical significance at a confidence level less than 0.001. In addition, the estimated causal effect of each contractor on the share of claims denied is reflected in their effects on other measures of administrative burden as well, as shown in Appendix B.

The differences in denial rates manifest themselves immediately upon the transition of a jurisdiction between contractors. Figure 4 reports estimates of the differential change in the denial rate when a jurisdiction transitions from a less to more stringent contractor relative to a transition to one that imposes a lower denial rate.¹³ After not having differential trends in denial rates prior to the transition, the denial rates change immediately upon transition depending on whether the transition is to a more or less stringent contractor. This difference is constant between 0.8 and 1.3 and is statistically-significant for each of the 18 months following the transition. After 18 months, the estimated difference in the denial rate is 1.24 percentage points higher, indicating a nearly 20% increase relative to the mean denial rate of 6.4%.

In addition to transitions to higher-denial administrator representing persistent increases in administrative burden, transitions to lower- as well as higher-denial administrators represent acute shocks to administrative burden. Figure 5 shows that for transitions of both types, the denial rate spikes immediately following the transition. Even for a transition to a lower-denial administrator, transitions between contractors result in changes in coverage rules and so may be disruptive to providers. Figure 5c shows that when aggregating across low-to-high and high-to-low transitions, the denial rate spikes sharply in the month of transition. I estimate that the denial rate in the month of transition is 0.613 percentage points higher in the month of

¹²The estimates are given relative to a large contractor called Noridian that current administers Medicare for much of the Mountain and Pacific West.

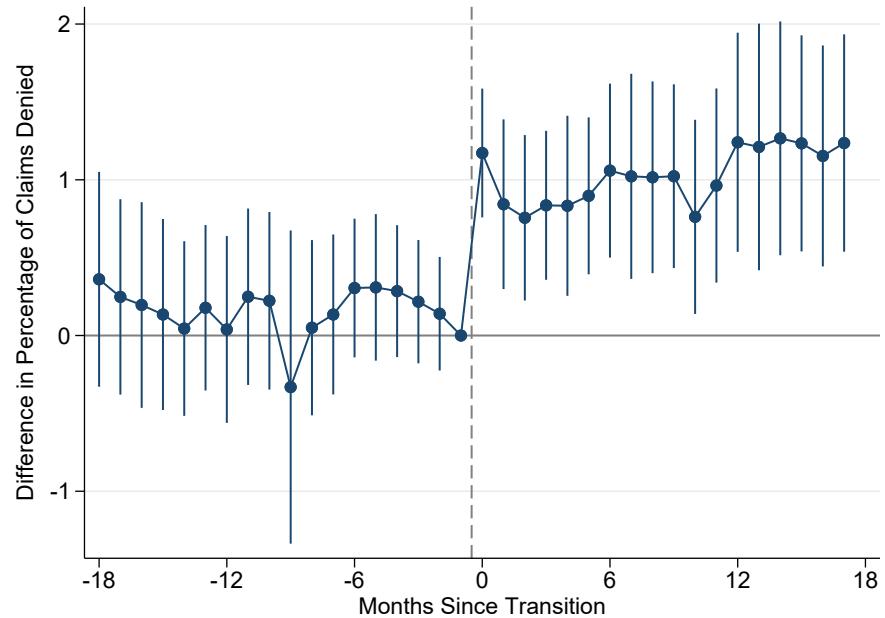
¹³Note that this result was not guaranteed ex ante. Whether the transition was from a lower- to higher-denial administrator or vice versa is determined by the estimates of the contractor's fixed effect in Equation 1, rather than the estimated change in the window surrounding transitions. Furthermore, in unreported robustness checks, I show that for transitions between contractors with larger differences in their estimated effect on denial rates, the change in denial rates is larger.

Table 3: Estimated Effect of Each Contractor on Denial Rates

	Denial Rate	Std. Error
Metra	1.859**	0.661
Nationwide	1.114**	0.431
Group Health	0.668	0.543
Triple-S	0.576	0.502
Pinnacle	0.410	0.518
BCBSRI	0.398	0.642
Wheatlands	0.350	0.512
TrailBlazer	0.342	0.459
NHIC	0.236	0.457
NGS	0.164	0.481
Novitas	-0.0161	0.532
WPS	-0.0928	0.452
Palmetto	-0.186	0.230
HealthNow	-0.356	0.521
FCSO	-0.659	0.453
Cahaba	-0.761	0.906
CGS	-1.061*	0.463
BCBSMT	-1.506***	0.167
Regence	-2.091***	0.251
TOLIC	-3.518***	0.699
Demographic Controls	Yes	
Month Fixed Effects	Yes	
Jurisdiction Fixed Effects	Yes	
Jurisdiction-Specific Trend	Yes	
Dep. Var. Mean	6.37	
R ²	0.8037	
Observations	12,996	

Notes: Estimates of γ_m of Equation (1). An observation is a jurisdiction-month. The excluded contractor is Noridian. Dependent variable is the share of claims denied. Standard errors are reported to the right of the point estimates and clustered by jurisdiction. +, *, ** and *** indicate significance at the 10%, 5%, 1% and 0.1% level, respectively.

Figure 4: Estimated Effect of Transition to Higher-Denial Administrator on Denial Rates



Notes: Estimates of δ_e of Equation (2) for $e \in \{-18, \dots, 17\}$. An observation is a jurisdiction-wave-month. Dependent variable is the share of claims denied. Error bars give the 95% confidence interval for each estimate. Standard errors are clustered by jurisdiction.

transition than the month before, a 9.7% increase from the baseline rate of 6.3%. After the initial spike, however, the denial rate gradually recovers to its pre-transition average (again, pooling transitions to higher- and lower-denial administrators) within 6 months. This denial rate behavior is consistent with providers having difficulty navigating the coverage and billing rules of the new administrator before gradually changing their behavior in response to the new coverage regime, as documented qualitatively by the Government Accountability Office.¹⁴ This pattern is also reflected other measures of administrative burden analyzed in Appendix B.

Transitions between administrators represent meaningful changes in the administrative burdens faced by providers, both because administrators differ in the administrative burdens they impose and because the transitions themselves are disruptive. Thus, by analyzing the way that providers alter their behavior following transitions between administrators, we can learn about the consequences of administrative burdens more generally.

5 Theoretical Framework

Changes in administrative burden could lead to a number of different responses by providers. Prior research has highlighted that providers have responded to burden by changing their billing practices (Ganju et al., 2022), the patients they accept (Dunn et al., 2021), the drugs they prescribe (Brot-Goldberg et al., 2022), and even whether they participate in the market at all (Eliason et al., 2021). Shi (2022) highlights that in response to increased audits of their admissions practices, hospitals adopt software that helps them abide by medical necessity requirements. The theoretical framework I outline below emphasizes this final investment channel, generating testable empirical predictions that I will show in Section 6 are borne out in the data.

Provider practices, or firms more generally, choose their level of investment in billing technology I to maximize profits:

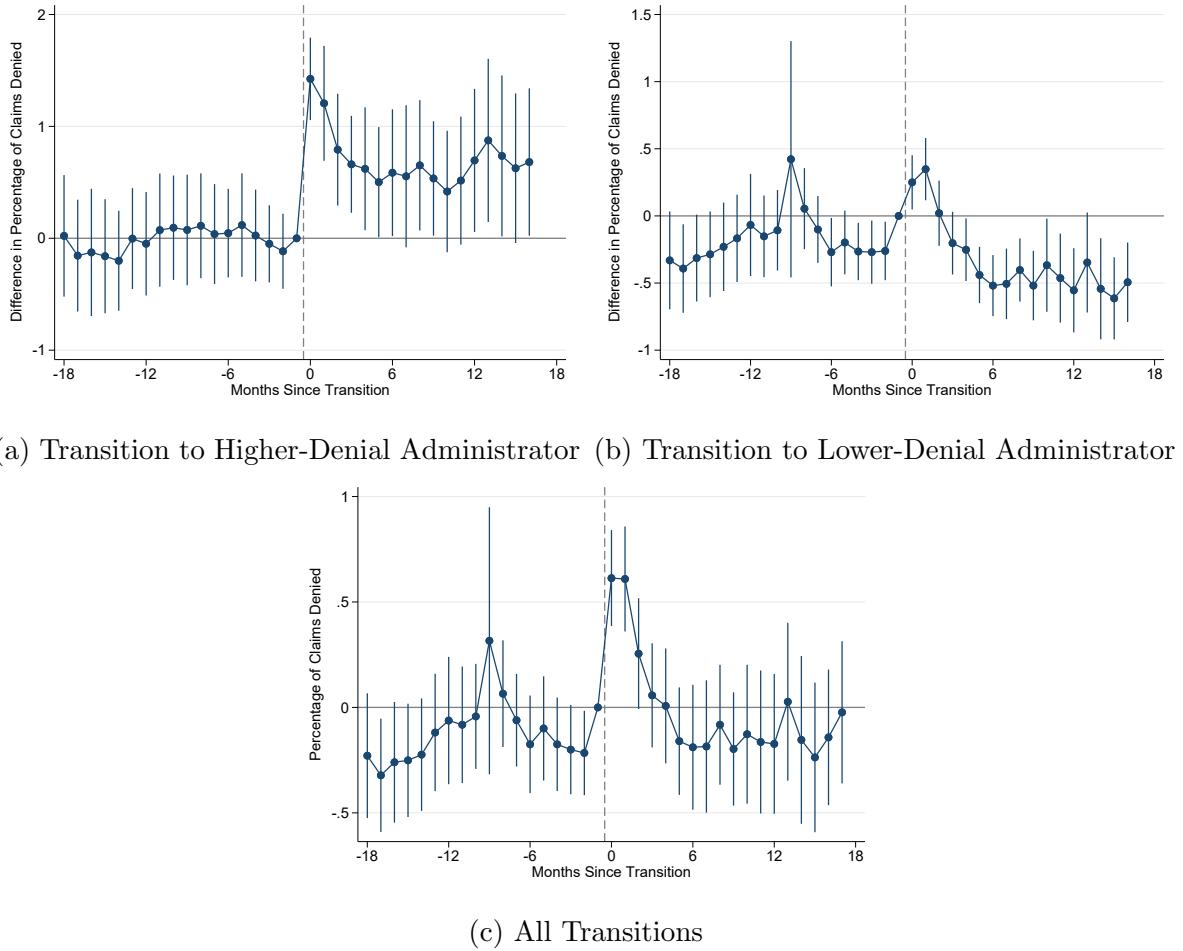
$$\max_I \Pi(I) = p(I)r(I)v - cI.$$

This investment can take many forms, including adopting information technology infrastructure like electronic health records, hiring additional staff to manage the revenue cycle and convert physician notes into medical claims, or other types of effort and investments that make billing easier.

Investment has two benefits to the firm in this model. First, it lowers the denial rate and

¹⁴GAO (2015) reports that the government “did not require Medicare Administrative Contractors to make this change (to stricter coverage rules) clear, causing payment denials providers did not anticipate,” with provider groups reporting “a lack of clear communication... which caused confusion once the local coverage determinations were finalized and claims were rejected.” This confusion is understandable given the extensive coverage rules contractors impose and the potential difficulty in changing medical and billing practices in light of them. As noted by the GAO report, the transitions involve hundreds of new rules being put out for public comment, which physicians reported being unable to review in a timely manner.

Figure 5: Denial Rate and Transition Dynamics



Notes: Estimates of β_e of Equation (3) for $e \in \{-18, \dots, 17\}$. An observation is a jurisdiction-wave-month. Dependent variables are the share of claims denied, the average number of days from a service being rendered to the final claim being processed, and the churn in charges by diagnosis and procedure from the previous month. Error bars give the 95% confidence interval for each estimate. Standard errors are clustered by jurisdiction. Panel (a) reports estimates using only transitions of a jurisdiction to an administrator with a higher estimated effect on denial rates, while panel (b) is limited to transitions to lower-denial administrators. Panel (c) reports estimates for all transitions.

increases the likelihood that a claim is paid in full. The function $p(I) \in [0, 1]$, which I assume is increasing, captures how the payment rate responds to this investment. Second, it makes firms able to extract more charges from the same patient encounter. This can entail reporting diagnoses that indicate a more severe condition for the patient or reporting that the provider rendered more (or more expensive) care. This behavior is called upcoding and has previously been shown to respond to investment in billing technology like electronic medical records (Sacarny, 2018; Ganju et al., 2022).¹⁵ For this reason, I assume that the charges per visit net of the cost of care $r(I) \geq 0$ are increasing in investment.¹⁶

The product of (i) the payment rate $p(I)$, (ii) the net charges per visit $r(I)$, and (iii) the volume of visits v gives the expected variable profit of the firm. To emphasize the role that firm size plays in investment decisions and the effects of administrative burdens, I stipulate that patient volume v is exogenous and does not depend on investment in billing technology.

The firm's costs are given by the product of the unit cost of investment c and the quantity of investment $I \geq 0$. For illustrative purposes, I assume that the cost of investment is entirely fixed with respect to patient volume, although in my empirical implementation of the model in Section 7, I relax this assumption.

Under mild conditions,¹⁷ the profit-maximizing level of investment I^* is given by

$$f(I^*; p(\cdot), r(\cdot), v, c) = \frac{\partial p}{\partial I^*} r(I^*) v + p(I^*) \frac{\partial r}{\partial I^*} v - c = 0.$$

The first of these terms represents the marginal increase in variable profit due to additional investment lowering the share of charges that are denied, the second term represents the marginal increase in variable profit coming from investment increasing charges per visit, and the final term is the marginal cost of investment. Thus, firms must trade off the additional variable profits generated by investment against its cost.

This model can be used to generate predictions about how firms will respond to changes in the administrative burden they face. We can think of an increase in administrative burden as

¹⁵This behavior is often worrying to policymakers (Silverman and Skinner, 2004; Dafny, 2005; Dafny and Dranove, 2009), although it can also represent an improvement in coding accuracy (Gowrisankaran et al., 2016). The model is agnostic on this point.

¹⁶I also assume that $p(\cdot)$ and $r(\cdot)$ are twice continuously differentiable and that $p(0) = 0$.

¹⁷The first condition is that the profit function is concave at I^* :

$$\frac{\partial f}{\partial I^*} = \frac{\partial^2 p}{\partial I^{*2}} r(I^*) v + 2 \frac{\partial p}{\partial I^*} \frac{\partial r}{\partial I^*} v + p(I^*) \frac{\partial^2 r}{\partial I^{*2}} v < 0.$$

For this to be true, it must be that investment exhibits diminishing marginal returns in terms of extracting charges or reducing denials or both. Note that because $p(\cdot)$ is monotonic, bounded above, and twice continuously differentiable, it must exhibit diminishing returns at some point. The second condition is that

$$\Pi(I^*) = p(I^*)r(I^*)v - cI^* \geq 0.$$

Otherwise the firm will not invest and will make 0 profit.

operating in two places in this model. The most straightforward is that it may increase the denial rate for all levels of investment ($p_1(I) \leq p_0(I)$ for all I), meaning that it is more difficult to extract payment from insurers with a given technology. The second, more subtle way that increased administrative burden may operate in this model is by improving the ability of billing technology to reduce denials ($\frac{\partial p_1}{\partial I} \geq \frac{\partial p_0}{\partial I}$ in a neighborhood around I^*). This channel would be activated by making the billing process more complicated such that the return to investing in technology to combat this burden is higher. Claim denials arise because complicating billing rules are not followed, so those rules becoming more complicated increases the return to investing in ways to navigate the billing process. Indeed, previous research has indicated that billing technology can allow providers to better adapt to and incorporate new billing rules (Sacarny, 2018).

Each of these two channels pushes the equilibrium level of investment in a different direction. The first “more denials” channel serves to lower the equilibrium investment because investing in technology to raise the charges per visit becomes less attractive when the yield rate of those charges goes down. To see this mathematically, note that

$$\frac{\partial I^*}{\partial p} = -\frac{\partial f}{\partial I^*}^{-1} \frac{\partial f}{\partial p} = -\frac{\partial f}{\partial I^*}^{-1} \frac{\partial r}{\partial I^*} v,$$

which is positive.¹⁸ The second “return to billing” channel serves to raise the equilibrium level of investment because it increases the marginal benefit of investing in billing technology. Mathematically, we see that

$$\frac{\partial I^*}{\partial \frac{\partial p}{\partial I^*}} = -\frac{\partial f}{\partial I^*}^{-1} \frac{\partial f}{\partial \frac{\partial p}{\partial I^*}} = -\frac{\partial f}{\partial I^*}^{-1} r(I^*) v,$$

which is also positive.

Which of these two effects dominates is theoretically ambiguous such that the equilibrium level of investment will increase in response to higher administrative burden only if the marginal profit from investment $f(\cdot)$ using the new denial function $p_2(\cdot)$ at the old equilibrium level of investment I^* is positive:¹⁹

$$\begin{aligned} f(I^*; p_2(\cdot), r(\cdot), v, c) &> 0 \\ \frac{\partial p_2}{\partial I^*} r(I^*) v + p_2(I^*) \frac{\partial r}{\partial I^*} v - c &> 0 \\ \frac{\partial p_2}{\partial I^*} r(I^*) + p_2(I^*) \frac{\partial r}{\partial I^*} &> \frac{c}{v}. \end{aligned}$$

¹⁸This result is an application of the implicit function theorem. It is positive because charges are increasing in investment ($\frac{\partial r}{\partial I} \geq 0$), volume is positive, and $\frac{\partial f}{\partial I^*}$ is negative (because I^* is the profit-maximizing rather than profit-minimizing level of investment)

¹⁹This condition is also sufficient if combined with the condition that the firm continues to operate in light of the new level of burden: $\Pi(I') > 0$.

This model generates a number of empirical predictions that I am able to assess using the changes in administrative burden represented by contractor transitions. First, while a larger burden can cause investment to increase or decrease, it will cause charges to move in the same way as investment.²⁰ Second, large firms will invest more because the fixed cost of investment does not depend on volume while the benefit of investment does.²¹ Finally, increasing administrative burden will lower firm profits, particularly among small firms that are closer to the threshold of exit.²²

6 Effects of Increased Burden

In this section, I show that providers react to increases in administrative burden by investing in technology that allows them to bill more aggressively and that the predictions of my theoretical model are supported by the data. This leads to my final, counterintuitive finding: increased denials *raise* Medicare spending.

6.1 Increased Burden Spurs Investment

First, I show that investment in billing technology increases following a transition to a higher-denial contractor. Increased administrative burdens may lead providers to adopt electronic health record (EHR) technology, a bundle of services that promise to make billing easier by automating more of the process. Previous research has shown that EHR adoption by hospitals is associated with increased charges (Agha, 2014), revenues (Ganju et al., 2022), and compliance with billing rules (Sacarny, 2018; Shi, 2022) as well as lower costs of billing (Gowrisankaran et al., 2019). Figure 6 presents estimates of the difference in EHR adoption rates in states that transition from lower-denial to higher-denial administrators between 2010 and 2015, both aggregated across years as well as broken out by the year of the transition. Across all years, the rate of EHR adoption increases following a transition to a higher-denial administrator, although this difference is consistently statistically significant only following transitions that occurred in 2011.

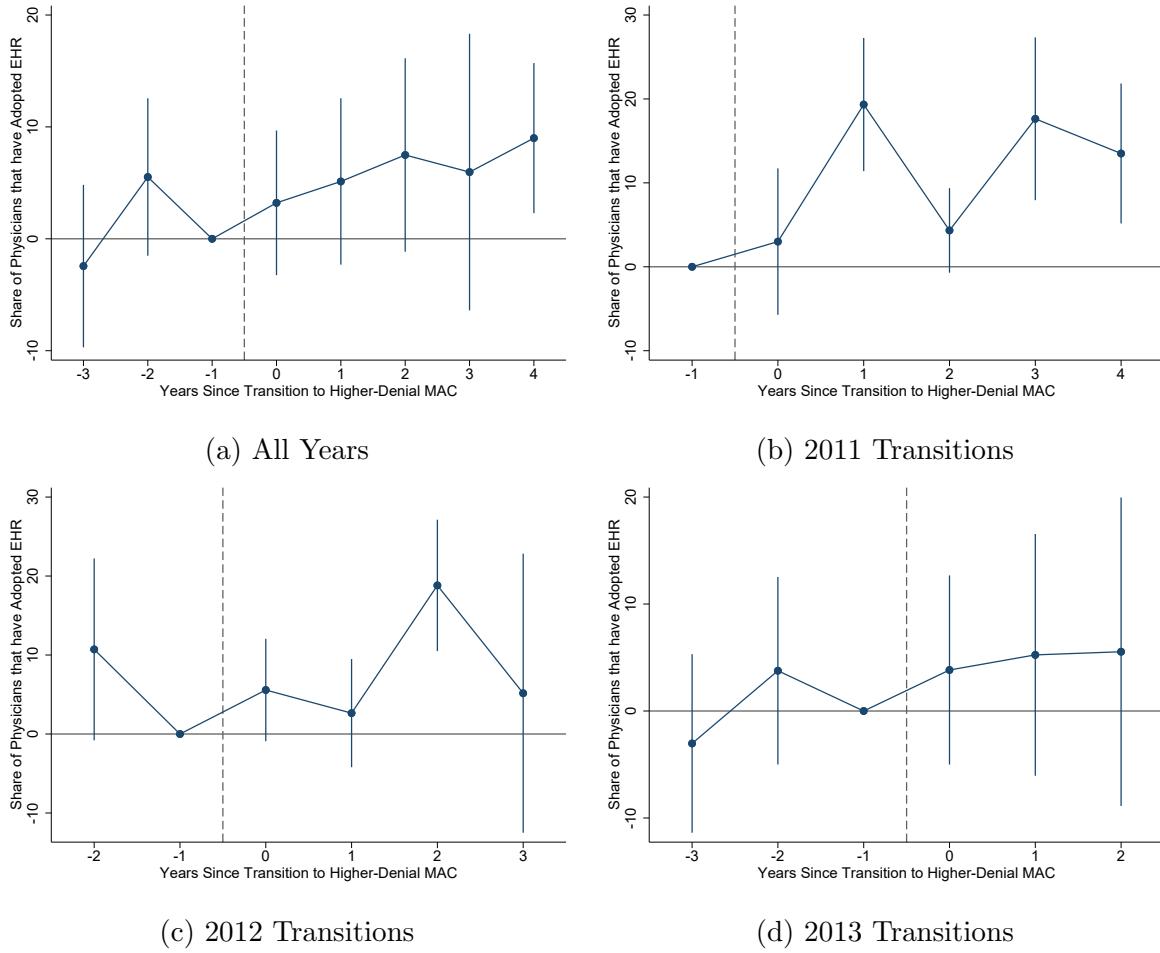
In line with this, I see that the charges submitted by providers to Medicare also increase following transitions to higher-denial administrators. Figure 7 shows that over time, transitions to contractors that are more aggressive with claim denials result in providers submitting more charges. This response is not immediate and instead gradually accumulates over time. As reported in Table 7, charges are \$47 per capita and 6 log points higher 18 months after transitioning

²⁰This is because of my assumption that $r(\cdot)$ is an increasing function.

²¹To see this, note that $\frac{\partial I^*}{\partial v} = -\frac{\partial f}{\partial I^*}^{-1} \frac{c}{v} > 0$.

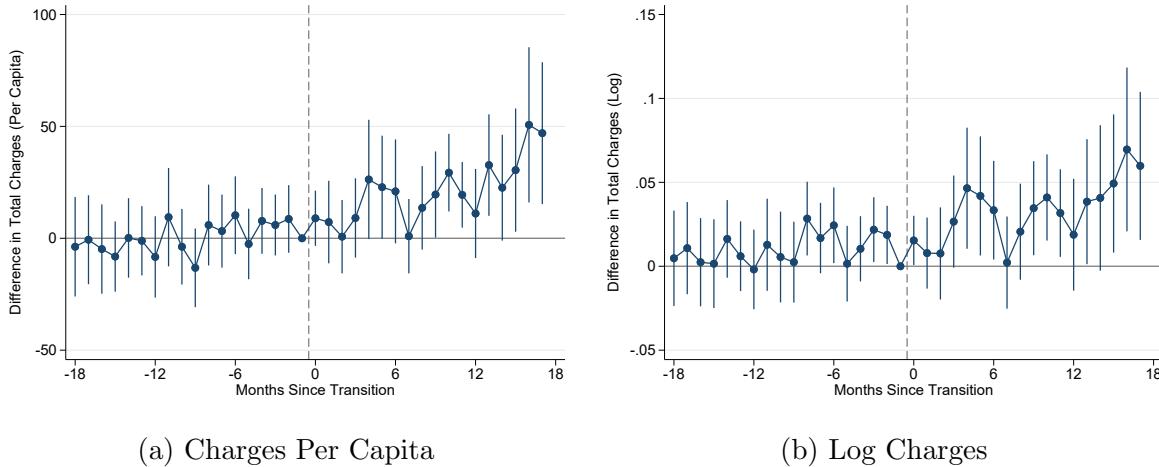
²²On the first point, note that $\frac{\partial \Pi(I^*)}{\partial p} = r(I^*)v > 0$ and $\frac{\partial \Pi(I^*)}{\partial \frac{\partial p}{\partial I^*}} = 0$ by the envelope theorem. On the second, note that small firms are less profitable: $\left(\frac{\partial \Pi(I^*)}{\partial v} = p(I^*)r(I^*) > 0 \right)$.

Figure 6: Effect of Transition to Higher-Denial Administrator on EHR Adoption



Notes: Estimates of δ_e of Equation (4) for $e \in \{-3, \dots, 4\}$. An observation is a state-year. Dependent variable is the share of office-based physician practices that have adopted basic EHR technology. Error bars give the 95% confidence interval for each estimate. Standard errors are clustered by state.

Figure 7: Effect of Transition to Higher-Denial Administrator on Charges



Notes: Estimates of δ_e of Equation (2) for $e \in \{-18, \dots, 17\}$. An observation is a jurisdiction-wave-month. Dependent variables are total charges billed measured per Medicare beneficiary or in logs. Error bars give the 95% confidence interval for each estimate. Standard errors are clustered by jurisdiction.

to a higher-denial-rate contractor, an increase of 6.2–7.6%. This increase in charges is consistent with firms investing more in technology and expending more effort to make billing easier and extract more charges from each visit.

6.2 Larger Firms Invest More

Next, I show evidence consistent with larger firms investing more in billing technology. First, larger firms have a smaller share of their claims denied. Figure 8 shows the share of claims denied by the number of providers billing Medicare under a single tax identification number. We see that while solo practitioners face an average denial rate of almost 9%, only 5% of claims are denied for the largest physician groups. Table 5 reports estimates of the association between firm size and denial rate within jurisdiction-month and with various weighting schemes. Even adjusting for jurisdiction-month specific differences in administrative burden and the standards of the administrator, the relationship between firm size and the denial rate remains strong, with an additional provider in the practice being associated with an average reduction in denial rate of 0.012 percentage points.

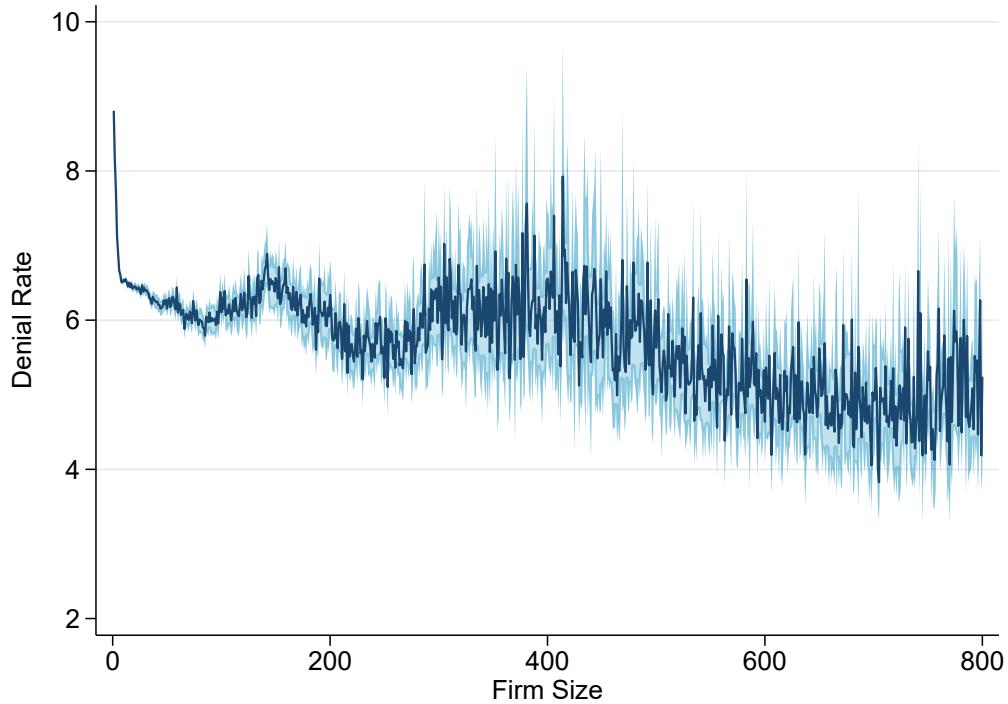
In addition to having lower denial rates on average, larger firms also experience smaller changes to their denial rates following contractor transitions. GAO (2015) has documented extensive evidence of confusion on the part of providers about new billing rules when a jurisdiction changes administrators, and as shown in Section 4.1, denial rates tend to spike in the months following a transition. Breaking the sample into quintiles based on the number of providers associated with the firm, we see that this spike is driven by the smallest firms. Figure 9 reports

Table 4: Effect of High-Denial Administrator on EHR Adoption and Charges

	(1) Share Adopt EHR	(2) Charges (per capita)	(3) Charges (log)
Increase in Denials	8.999** (3.338)	46.97** (16.17)	0.0598** (0.0225)
Dep. Var. Mean	43.00	616.2	17.58
Observations	305	70,164	70,164

Notes: Column (1) reports estimates of δ_4 of Equation (4) where an observation is a state-year. Columns (2) and (3) report estimates of δ_{17} of Equation (2) with $K = 18$ and $L = 17$ where observation is a jurisdiction-wave-month. Dependent variables are the share of practices that have adopted electronic health records and the total charges billed to Medicare per beneficiary and in logs. Standard errors are clustered by state in column (1) and by jurisdiction in columns (2) and (3). +, *, ** and *** indicate significance at the 10%, 5%, 1% and 0.1% level, respectively.

Figure 8: Relationship Between Firm Size and Denial Rate



Notes: Figure reports the average denial rate by firm size for firms with up to 800 providers. An observation is a firm-month. Firm size is determined by the number of providers in a jurisdiction billing under the same tax identification number. 95% confidence interval given in light blue.

Table 5: Difference in Denial Rate by Firm Size

	(1) Denial Rate	(2) Denial Rate	(3) Denial Rate	(4) Denial Rate
Firm Size	-0.0121*** (0.000961)	-0.0121*** (0.000943)	-0.00191*** (0.000323)	-0.00163*** (0.000307)
Jurisdiction-Month FEs	0	1	0	1
Weighting	Firms	Firms	Providers	Providers
Dep. Var. Mean	8.397	8.397	7.024	7.024
Observations	61,725,317	61,725,317	199,100,357	199,100,357

Notes: Estimates from regression of denial rate on firm size. An observation is a firm-month. Firm size is determined by the number of providers in a jurisdiction billing under the same tax identification number. Jurisdiction-month fixed effects are included in columns (2) and (4), and observations are frequency-weighted by the number of providers associated with the firm in columns (3) and (4). Standard errors are clustered by firm. +, *, ** and *** indicate significance at the 10%, 5%, 1% and 0.1% level, respectively.

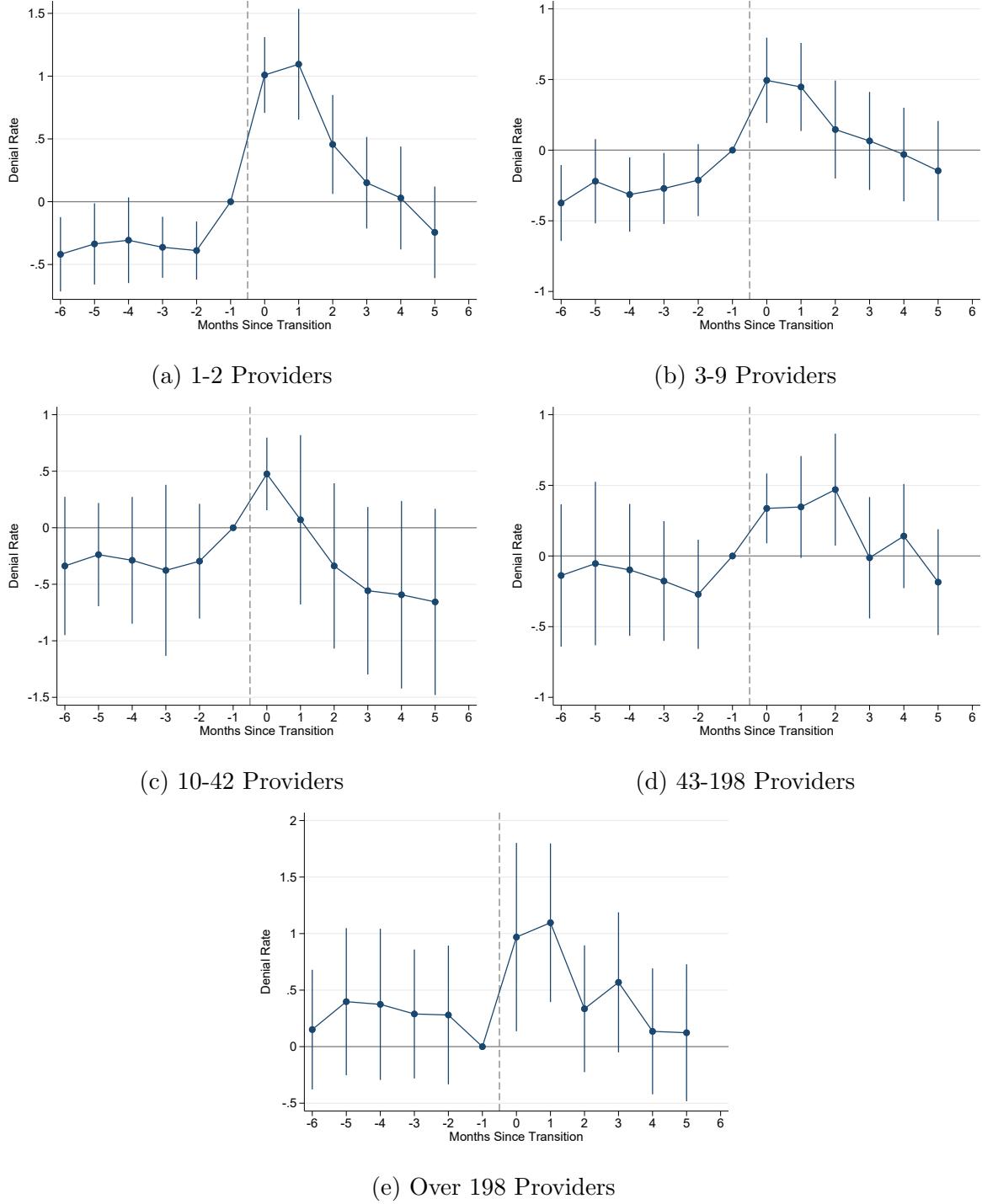
Table 6: Effect of Transition on Denials by Firm Size

	(1) Denial Rate	(2) Denial Rate	(3) Denial Rate	(4) Denial Rate	(5) Denial Rate
Post-Transition	0.720*** (0.134)	0.395*** (0.108)	-0.00916 (0.142)	0.306+ (0.164)	0.290 (0.165)
Firm-Size Quintile	1	2	3	4	5
Dep. Var. Mean	7.474	6.232	5.801	6.449	5.354
Observations	30,144	30,144	30,144	30,084	27,768

Notes: Estimates of δ_1 of Equation (8) for $L = 5$. An observation is a jurisdiction-wave-month. Dependent variable is the denial rate for firms of the relevant size. Error bars give the 95% confidence interval for each estimate. Standard errors are clustered by jurisdiction.

how the denial rate changes surrounding administrator transitions for firms of various sizes, while Table 6 reports total change in the six months following a transition. While one- or two-provider practices see their denials jump by three-quarters of a percentage point following a contractor change, for the largest firms this spike is only half as large. This result is consistent with larger firms investing more in technology that allows them to more easily detect and respond to changes in billing rules and maintain a low denial rate.

Figure 9: Effect of Transition on Denials by Firm Size



Notes: Estimates of β_e of Equation (3) for $e \in \{-6, \dots, 5\}$. An observation is a jurisdiction-wave-month. Dependent variable is the denial rate for firms of the relevant size. Error bars give the 95% confidence interval for each estimate. Standard errors are clustered by jurisdiction.

6.3 Increased Burden Lowers Profits and Increases Concentration

The third testable implication of my model is that increasing burdens will reduce firm profits. That is, fewer firms will operate following an increase in administrative burden.²³ As Figure 10a shows, this prediction is supported by the data. Transitions to higher-denial administrators result in roughly 1% fewer firms operating in the three months after the transition relative to the month before and the number of firms remaining well below trend thereafter. As shown by Figures A2 and A3 in Appendix D, even the disruptions associated with transitions to lower-denial administrators induce exit, although much less so than for transitions to higher-denial administrators.

The theoretical model also predicts that exit will be most likely for small practices because these firms will make lower profits and be closer to the threshold of exit. Consistent with this, I find that exit is driven by the smallest firms while undetectable for larger firms. Immediately following a transition to a higher-denial administrator, the number of single-provider firms drops by 1.9%, leading to an immediate change in the size distribution of firms. The share of providers in solo practice drops 0.2 percentage points (1.2%) and the average number of providers per firm increases 0.04 (1.1%) in the month following a transition to a higher-denial administrator. These results indicate that increasing administrative burdens advantages larger firms and leads to increased firm size.

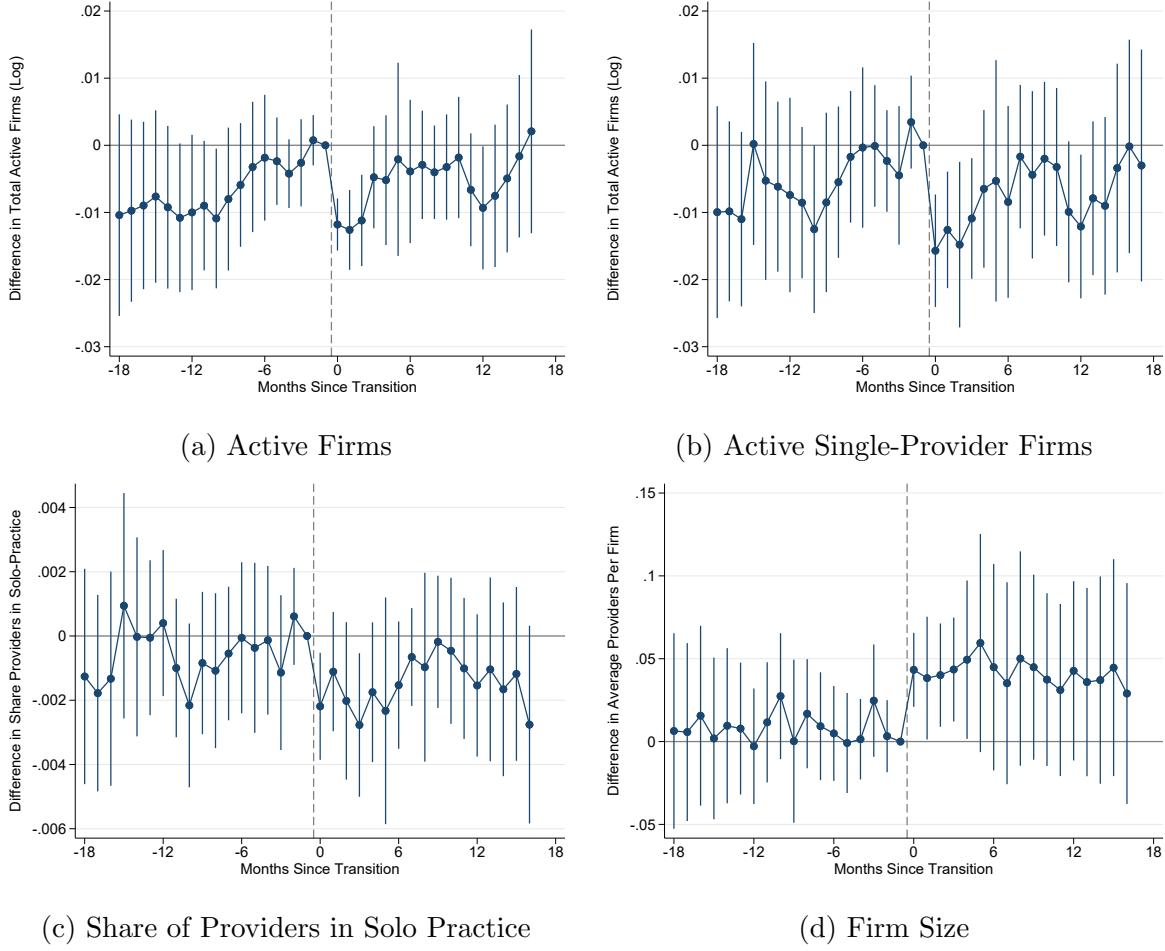
6.4 Other Impacts of Increased Burden

Finally, although the model does not make any prediction on this point, the net effect of the additional investment and consolidation is to increase the overall level of Medicare spending following a transition to a higher-denial administrator. This indicates that all of the additional billing costs imposed on providers that lead to consolidation do not reduce spending for Medicare. Both Medicare and providers would be better off with lower denial rates—Medicare because total spending would be lower and providers because they could avoid inefficient investment costs.

Despite failing to achieve their putative aim of reducing health care spending, administrative burdens may improve patient care. Although administrative burdens are generally targeted toward combating waste and inefficiency, they can also be used to protect patients and encourage higher-value, more-effective care. Examples of these types of burdens include real time denials for prescription drugs that may have dangerous interactions with one another as well as claim denials for care known to be wasteful. In Appendix E, I show that differences between administrators in the treatment of claims for low-value care can induce providers to change their provision of these services, but that very large changes in denials are necessary. This indicates that while

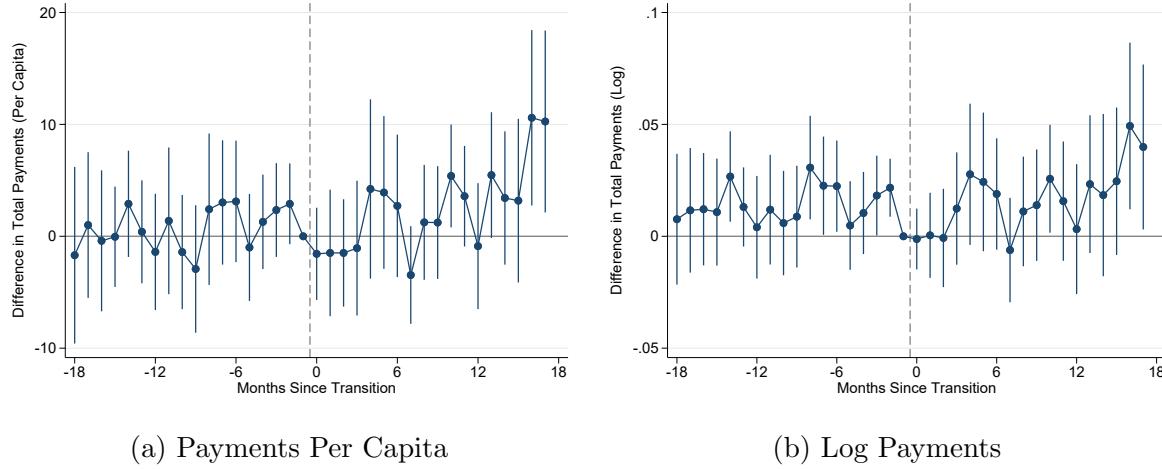
²³This is true assuming that the change in administrative burden represented by the transitions I study move firms of some particular size v from having positive to negative profits. Alternatively, this will also be true if profits are subject to idiosyncratic differences within firm-size bands as I assume in Section 7.

Figure 10: Effect of Transition to Higher-Denial Administrator on Market Structure



Notes: Estimates of β_e of Equation (3) for $e \in \{-18, \dots, 17\}$. An observation is a jurisdiction-wave-month. The sample is limited to transitions to a higher-denial administrator and appropriate control jurisdictions. Dependent variables are the number of active firms and the number of single-provider active firms (both in logs), the share of providers affiliated with single-provider firms, and the firm-level average number of providers per firm. Error bars give the 95% confidence interval for each estimate. Standard errors are clustered by jurisdiction.

Figure 11: Effect of Transition to Higher-Denial Administrator on Spending



Notes: Estimates of δ_e of Equation (2) for $e \in \{-18, \dots, 17\}$. An observation is a jurisdiction-wave-month. Dependent variables are total Medicare payments measured per Medicare beneficiary and in logs. Error bars give the 95% confidence interval for each estimate. Standard errors are clustered by jurisdiction.

large, highly salient burdens can alter care provision—as is the case with prior authorization (Eliason et al., 2021; Brot-Goldberg et al., 2022)—subtle differences in billing rules are unlikely to have a material impact on the provision of care. In line with this, I find no change in aggregate beneficiary mortality following a transition to a higher-denial administrator, as shown in Figure A4 in Appendix D. The estimated change in mortality after a transition is close to zero but is somewhat imprecise (I cannot rule out increases or decreases in mortality of up to 1.9% at the 95% confidence level). Although I cannot rule out changes in mortality for all patients, previous research in settings where administrative burdens clearly alter the provision of care generally fails to find evidence of changes in patient outcomes (Eliason et al., 2021; Brot-Goldberg et al., 2022; Macambira et al., 2022). In my context, there is little evidence that claim denials lead to large changes in the actual provision of care and, accordingly, little change in outcomes for patients, supporting my focus on investment in billing technology and changes in reporting as the primary responses of providers.

6.5 Discussion

My results indicate that increased administrative burdens lead to higher Medicare spending and increased consolidation, which are both negative, unintended outcomes. Previous research has documented extensive harms that come from consolidation in the health care system, including higher prices (Gaynor and Vogt, 2003; Dafny, 2009; Gowrisankaran et al., 2015; Cooper et al., 2019), less access to care (Town et al., 2006, 2007), lower wages (Prager and Schmitt, 2021), and few improvements in health outcomes (Cutler et al., 2010; Gaynor et al., 2013; Bloom et al.,

Table 7: Effect of Higher-Denial Administrator on Medicare Spending

	(1) Payments (per capita)	(2) Payments (log)
18-Months Post-Transition	10.26* (4.147)	0.0399* (0.0188)
Dep. Var. Mean	227.0	16.61
Observations	70,164	70,164

Notes: Estimates of δ_{17} of Equation (2) with $K = 18$ and $L = 17$. An observation is a jurisdiction-wave-month. Dependent variables are total Medicare payments measured per Medicare beneficiary and in logs. Standard errors are clustered by jurisdiction. +, *, ** and *** indicate significance at the 10%, 5%, 1% and 0.1% level, respectively.

2015; Eliason et al., 2020). My results shed light on one particularly contentious issue when these mergers are reviewed by competition authorities: the potential for cost savings and returns to scale. Indeed, my results are consistent with larger physician groups and health systems being better able to invest in the fixed costs of billing technology. Indeed, a recent survey of financial executives involved in hospital mergers found that investments in health IT such as electronic medical records and billing software were the most common use of new capital generated by the merger (Knapp et al., 2017). Importantly though, my results also indicate that one driver of this consolidation (and all the ills it often entails) is that administrative burdens cause fixed costs to increase in ways that necessitate larger firms.

Industry watchers have long warned about this result. For example, Daly (2018) argues that “smaller hospitals lack the capital to... make necessary investments in information technology and clinical systems that are required in order to operate efficiently and effectively in the current environment,” and Smidt (2015) argues the “complex and far reaching” regulatory environment is “leading hospitals to increase their IT know-how and equipment capabilities through mergers and acquisitions.” Despite these widespread worries, to my knowledge there have been no studies investigating the link between market structure and claim denials, billing complexity, and administrative burden.

Even beyond the impact on market structure, investment would still be socially wasteful in the context of the model. It serves to only determine transfers between the government and health care providers, but at a real cost. This is consistent with the idea of an “administrative arms race” (Cutler, 2018), where insurers impose burdens and require more complex billing in an attempt to reduce payments to providers but providers respond by investing in more administrative architecture to claw back this revenue. This in turn leads insurers to impose yet higher burdens that providers then attempt to circumvent. Such a prisoners’ dilemma is socially wasteful and highlights the benefits that would come from imposing fewer administrative burdens.

Outside of the model, though, investment in billing technology can potentially have benefits for patients and payers. For example, insurers may value the improved accuracy of billing leading to fewer worries about fraud and improper payments while policymakers have touted the potential for health IT to improve coordination of care across providers and transparency to consumers (Gowrisankaran et al., 2019; Miller and Tucker, 2011; Atasoy et al., 2018).

These potential benefits seem unlikely to outweigh the costs of raising burdens at the margin, however. As I show, net spending increases following a hike in the denial rate, indicating that any investment did not translate into improved care preventing unnecessary spending. Furthermore, the existing evidence on whether the adoption of electronic health records improves patient health outcomes is mixed (Agha, 2014) with the weight of the evidence indicating only modest effects on patient health (Bronsolier et al., 2022). Furthermore, investments in billing technology other than electronic health records, such as hiring scribes and coders, are even less likely to improve patient care. Finally in Appendix E, I show that denial rate changes are unlikely to shift providers away from known forms of low-value health care, with transitioning between administrators with divergent stances toward 7 types of low value care only reducing the utilization of the treatment subject to the largest (20 percentage point) change in denials. The inability for after-the-fact denials to alter medical care is also highlighted by Macambira et al. (2022). Together, these results indicate that the costs of administrative burdens that I highlight are unlikely to be outweighed by their potential benefits.

7 Empirical Model

Although my results indicate that the costs of administrative burdens are high, my model may not capture all the benefits of administrative costs and investment in billing technology. Because of this limitation, I want to quantify the costs of compliance so that policymakers can better judge if these potential benefits are worth the costs they impose. To do this, I estimate a parameterized version of the theoretical model presented in Section 5, which will allow me to not only quantify firms' compliance costs but also better understand how they would respond to policy changes.

To estimate the model, I parameterize the denial rate as depending on the difference of investment and a minimum level of investment \underline{I} divided by the level of investment plus a term a that governs how quickly the returns to investment diminish:

$$p(I) = \begin{cases} \frac{\underline{I}-I}{\underline{I}+a} & \text{if } I \geq \underline{I} \\ 0 & \text{otherwise} \end{cases}.$$

This functional form means that the payment rate is zero for all levels of investment less than

or equal to the minimum level of investment and then asymptotically approaching one as the level of investment increases. I parameterize charges as depending linearly on investment plus a constant that governs the amount of charges a firm would be able to extract from a visit with no investment: $r(I) = rI + b$.

On the cost side of the equation, I relax the assumption of the theoretical model that investment costs are fixed regardless of patient volume and allow the unit cost of investment to depend linearly on volume such that the cost of investment level I is given by $c(I) = (c + dv) \times I$.

With this parameterization, the profit-maximizing level of investment is

$$I^* = \sqrt{\frac{v(b - ar)(a + \underline{I})}{c + (d - r)v}} - a$$

under the assumptions that $c + (d - r)v > 0$, $(c + dv)(\underline{I} + a) < v(r\underline{I} + b)$, and that the firm makes non-negative profit at this level of investment. While I do not observe investment directly, there are one-to-one mappings between investment and charge and payment rates. This means that the first order condition can be written in terms of these observed variables:

$$\begin{aligned} r(I^*) &= r \sqrt{\frac{v(b - ar)(a + \underline{I})}{c + (d - r)v}} + b - ra \\ p(I^*) &= 1 - \sqrt{\frac{(a + \underline{I})(c + (d - r)v)}{v(b - ar)}}. \end{aligned}$$

Finally, I allow each firm i 's profits in month t in jurisdiction j to have an idiosyncratic error term ε_{ijt} that I assume is normally distributed with mean zero and an unknown standard deviation σ_π .²⁴ Thus, firm profits are given by

$$\Pi_{ijt} = p(I_{ijt})r(I_{ijt})v - (c + dv)I_{ijt} + \varepsilon_{\pi,ijt}.$$

This parameterization yields moments that are closely related to the reduced-form results presented earlier. Under the assumption that immediately around contractor transitions, the only thing that changes is the minimum level of investment (which captures the administrative burden imposed by the Medicare Administrative Contractor), the following three equations report the relationship between the model parameters and the predicted change in charges, denials, and the number of active firms:

$$(5) \quad \mathbb{E}[\tilde{R}_{ij1}] - \mathbb{E}[\tilde{R}_{ij0}] = r \sqrt{\frac{v(b - ar)}{c + (d - r)v}} \left(\sqrt{a + \underline{I}_1} - \sqrt{a + \underline{I}_0} \right)$$

²⁴Note that I assume ε_{ijt} is only incurred if the firm invests at a level $I \geq \underline{I}$. This assumption ensures that all firms with positive profits invest at I^* while no firm with negative profits invests at all.

$$(6) \quad \mathbb{E}[\tilde{P}_{ij1}] - \mathbb{E}[\tilde{P}_{ij0}] = \sqrt{\frac{c + (d - r)v}{v(b - ar)}} \left(\sqrt{a + \underline{I}_0} - \sqrt{a + \underline{I}_1} \right)$$

$$(7) \quad \frac{N_{vj1}}{N_{vj0}} = \frac{1 - \Phi\left(\frac{-\Pi_{ij1}}{\sigma_\pi}\right)}{1 - \Phi\left(\frac{-\Pi_{ij0}}{\sigma_\pi}\right)},$$

where $\tilde{R}_{ijt} = r(I_{ijt}) + \epsilon_{r,ijt}$ and $\tilde{P}_{ijt} = p(I_{ijt}) + \epsilon_{p,ijt}$ are the observed charges and denial rate that depend on mean-zero measurement error and N_{vjt} is the number of firms of size v operating in jurisdiction j and time t . The first two moments set the change in average charges and denials equal to the predicted change from the model coming from the reoptimization of the level of investment in light of the change in minimum investment. The third moment is that the change in the ratio of active firms after the transition relative to before is equal to the ratio of the share of firms with positive profits at the two profit-maximizing levels of investment.

These moments are useful because the left hand side of each of the moments is identified in the reduced form. Estimating the equation

$$(8) \quad Y_{jtw} = \beta_1 \sum_{e=0}^L T_{jtw}(e) + \delta_1 \sum_{e=0}^L T_{jtw}(e) \times U_w + \Gamma X_{jtw} + \alpha_{jw} + \eta_{tw} + \varepsilon_{jtw},$$

using the stacked regression estimator discussed in Section 4 limited to firms of size v gives me estimates of the left-hand side of each of the moments. With the number of active firms in logs as the dependent variable $\frac{N_{vj1}}{N_{vj0}}$ is given by $\delta_1 + 1$; with charges per provider, $\mathbb{E}[\tilde{R}_{1jt}] - \mathbb{E}[\tilde{R}_{0jt}]$ is given by δ_1 , and with the denial rate, $\mathbb{E}[\tilde{P}_{1jt}] - \mathbb{E}[\tilde{P}_{0jt}]$ is given by $-\delta_1$. Under the identifying assumption that in the windows around transitions between low- and high-denial administrators, the only differential change in the model parameters is in the level of administrative burden \underline{I} , I can estimate the parameters of the theoretical model using the reduced-form estimates of δ_1 for various outcomes and firm sizes.

I supplement these transition-based moments with two moments that characterize the relationship between denials and firm size. Recall that the payment rate at the profit-maximizing level of investment is given by

$$p(I^*) = 1 - \sqrt{\frac{(a + \underline{I})(c + (d - r)v)}{v(b - ar)}}.$$

This can be rewritten to make it clear that there is a linear relationship between simple trans-

formations of the denial rate and firm size:

$$(1 - p(I^*))^2 = \frac{(a + \underline{I})(d - r)}{b - ar} + \frac{(a + \underline{I})c}{b - ar} \frac{1}{v}.$$

Each of these terms can be recovered by estimating the equation

$$(9) \quad SqDeny_v = \beta_0 + \beta_1 \frac{1}{v} + \varepsilon_v,$$

where $SqDeny_v$ is the square of the average denial rate for firms of size v and ε_v is mean-zero measurement error in the average denial rate for firms of size v .²⁵ This generates two more moments that can be used to estimate the parameters of the model:

$$(10) \quad \beta_0 = \frac{(a + \underline{I})(d - r)}{b - ar}$$

$$(11) \quad \beta_1 = \frac{(a + \underline{I})c}{b - ar}$$

I have eight parameters (\underline{I}_0 , \underline{I}_1 , a , r , b , c , d , and σ_π), three size-specific moments, and two moments that characterize the relationship between denials and firm size. I parameterize v as the number of providers associated with the same TIN in a jurisdiction. Because of compositional concerns, I rely on single-provider firms to characterize the change in profits in estimation.²⁶ More specifically, I use the moment represented by Equation (7) only with $v = 1$. In contrast, I rely on firms of all sizes to estimate the change in charges and denials (represented by Equations (5) and 6, respectively). To simplify estimation and improve precision, I group firms into quintiles by size and use the mean firm size within each quintile as the value of v for that moment to estimate the change in denials. For the change in charges, I group all firms together and use the mean overall firm size as the value of v . For the moments that characterize the cross-sectional relationship between claim denials and firm size, I parameterize the minimum level of investment

²⁵Note that $SqDeny_v$ is the square of the average denial rate rather than the average of the squared denial rate. Were $SqDeny_v$ defined in the latter way, ordinary least-squares would generate biased estimates of β_0 and β_1 in the presence of firm-level measurement error of the denial rate. This is because

$$E \left[\left(1 - \tilde{P}_{ijt} \right)^2 | v \right] = \frac{(a + \underline{I})(d - r)}{b - ar} + \frac{(a + \underline{I})c}{b - ar} \frac{1}{v} + \sigma_{\epsilon,v}^2,$$

where $\sigma_{\epsilon,v}^2$ is the variance of the measurement error of denial rates for firms of size v . If this measurement error is non-zero, the OLS estimate of β_0 would be biased upward. If the variance of the measurement error is correlated with firm size, then the OLS estimate of β_1 would be biased in the direction of this correlation.

²⁶Estimating the change in the number of firms for larger firm sizes would violate the identifying assumption that the number of potential firms of that size is unchanged around the transition. Because the providers associated with exiting firms are able to reallocate to other firms, the number of potential firms of larger size grows following transitions to a higher-denial administrator.

to be the average of the pre- and post-transition levels ($\frac{I_0+I_1}{2}$). I estimate parameter values to minimize the weighted sum of squared difference between the left- and right-hand sides of each of the eight moments reported in Table 8. To discount less-precisely estimated left-hand side values, I weight each moment by the square of the standard error of my estimate of the left-hand side.

7.1 Estimation Results

Table 8 reports details on the moments used in estimation and estimates for the value of the left-hand side of the moment. Notice that the estimates are consistent with the predictions of the model: there are fewer firms in the market following a transition to a higher-denial administrator while charge increase. Even more starkly, we see that denials increase for firms of all sizes, but the size of this increase is smaller for larger firms.

More importantly, the values presented in Table 8 identify the parameters of the structural model. Table 9 reports estimates of these parameters. In Appendix F, I present evidence that the estimated model is successful in matching the moments used in estimation as well as other patterns in the data. In particular, under the null hypothesis that the estimated model is correct, none of the estimated values reported in Table 8 differ in a statistically significant way from the predictions of the model.

While these parameters are difficult to interpret, they imply that the investment cost of raising total charges by \$1 for a solo practitioner is \$2.77 while the cost of lowering the denial rate by one percentage point is \$355 per month.²⁷ Furthermore, the estimates indicate that investment costs have substantial components that are both fixed and variable relative to firm size. As shown by Figure 12a, the per-provider unit cost of investment is decreasing in firm size due to the fixed-cost component, but never approaches zero due to the non-zero variable cost. This lower per-provider unit cost induces additional investment on the part of large providers (Figure 12b), with the net effect being that equilibrium average costs are strongly decreasing in firm size up to 6 providers before slowly increasing thereafter (Figure 12c). This results in larger firms being more profitable, including on a per-provider basis, as shown by Figure 12d.

The model estimates imply that the costs of compliance with billing rules are high: solo practitioners invest \$2,400 each month in billing technology while the median provider is in a firm that invests \$26,100 per month.²⁸ This amounts to 13.3% and 12.6%, respectively, of variable profits from Medicare being absorbed by billing costs. Aggregating these costs across all firms billing Medicare in 2017, I find that the total investment costs amount to \$30.7 billion.

These cost estimates are consistent with existing estimates of administrative costs, lending

²⁷All cross-sectional estimates of billing costs and equilibrium outcomes assume the minimum level of investment is given by $I_{avg} \equiv \frac{I_0+I_1}{2}$.

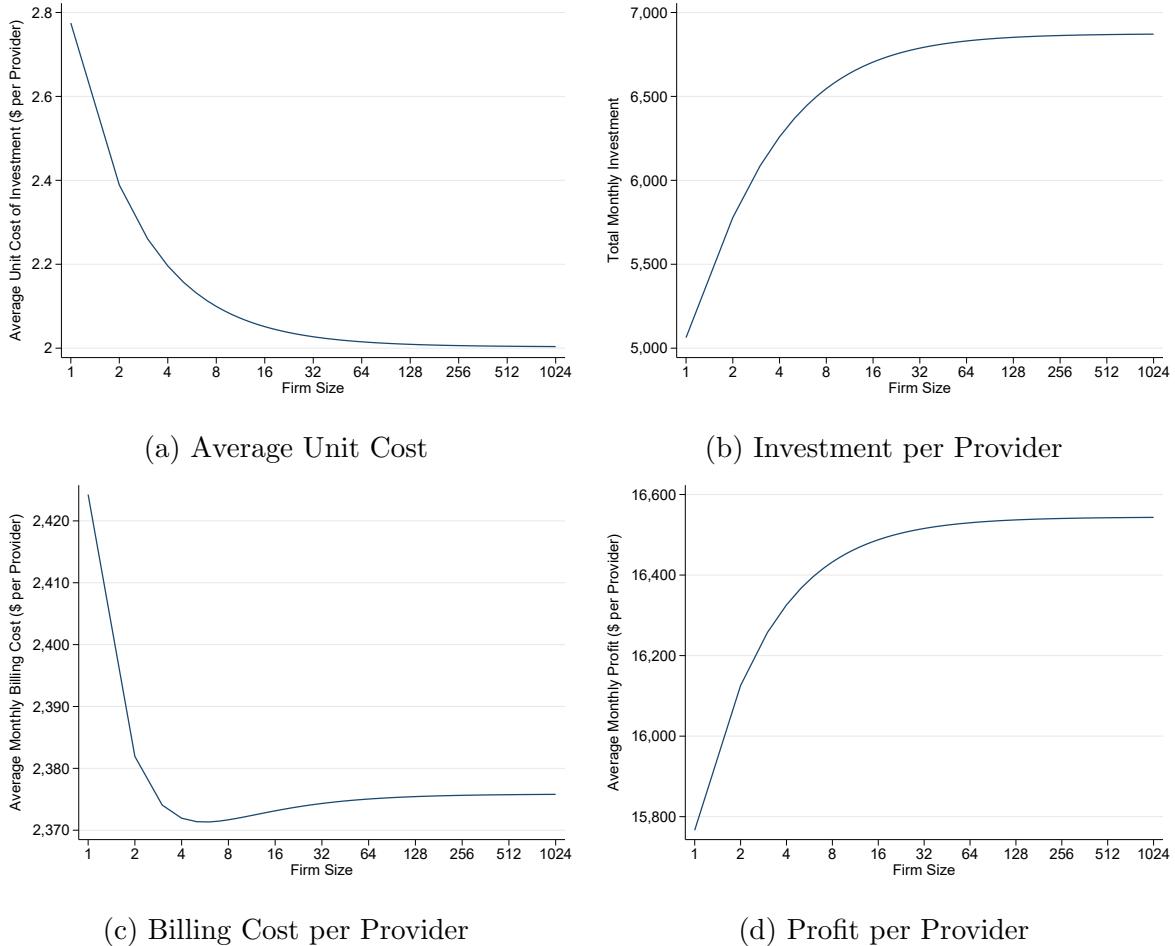
²⁸The median provider is in a firm with 11 total providers.

Table 8: Estimated Moments

(1) Moment Equation	(2) Firm Sizes	(3) Estimand	(4) Structural Parameter	(5) Estimate
Equation (7)	1	$\frac{N_{v,j1}}{N_{v,j0}}$	$\frac{1-\Phi\left(\frac{-\Pi_{ij1}}{\sigma_\pi}\right)}{1-\Phi\left(\frac{-\Pi_{ij0}}{\sigma_\pi}\right)}$	0.99614 (0.00711)
Equation (6)	1	$\mathbb{E}[\tilde{P}_{ij1}] - \mathbb{E}[\tilde{P}_{ij0}]$	$\sqrt{\frac{c+d-r}{b-ar}}\Delta$	-0.01093 (0.00261)
Equation (6)	2–5	$\mathbb{E}[\tilde{P}_{ij1}] - \mathbb{E}[\tilde{P}_{ij0}]$	$\sqrt{\frac{c+(d-r)3.0424099}{3.0424099(b-ar)}}\Delta$	-0.01089 (0.00261)
Equation (6)	6–21	$\mathbb{E}[\tilde{P}_{ij1}] - \mathbb{E}[\tilde{P}_{ij0}]$	$\sqrt{\frac{c+(d-r)11.7714}{11.7714(b-ar)}}\Delta$	-0.00832 (0.00245)
Equation (6)	22–104	$\mathbb{E}[\tilde{P}_{ij1}] - \mathbb{E}[\tilde{P}_{ij0}]$	$\sqrt{\frac{c+(d-r)49.764092}{49.764092(b-ar)}}\Delta$	-0.00940 (0.00249)
Equation (6)	≥ 104	$\mathbb{E}[\tilde{P}_{ij1}] - \mathbb{E}[\tilde{P}_{ij0}]$	$\sqrt{\frac{c+(d-r)517.64321}{517.64321(b-ar)}}\Delta$	-0.00460 (0.00295)
Equation (5)	All	$\mathbb{E}[\tilde{R}_{ij1}] - \mathbb{E}[\tilde{R}_{ij0}]$	$-r\sqrt{\frac{v(b-ar)}{c+(d-r)v}}\Delta$	140.2 (70.64)
Equation (10)	All	β_0	$\frac{(a+\underline{I}_{avg})(d-r)}{b-ar}$	44.16 (2.50)
Equation (11)	All	β_1	$\frac{(a+\underline{I}_{avg})c}{b-ar}$	33.91 (2.34)

Notes: Column (1) reports the equation that defines the moment to be estimated. Column (2) reports the number of providers associated with the firms to which the estimation sample is limited. Columns (3) and (4) report the estimand associated with the moment and the combination of structural parameters to which it is equivalent. Note that $\Delta \equiv \sqrt{a + \underline{I}_0} - \sqrt{a + \underline{I}_1}$ and $\underline{I}_{avg} \equiv \frac{\underline{I}_0 + \underline{I}_1}{2}$. For the moment associated with Equation (7), column (5) reports estimates of $\delta_1 + 1$ of Equation (8) with log number of active firms as the dependent variable. For the moments associated with Equation (6), column (5) reports estimates of $-\delta_1$ of Equation (8) with share of claims denied as the dependent variable. For these estimates, an observation is a jurisdiction-wave-month-quintile, and the standard errors are reported in parentheses and clustered by jurisdiction. For the moment associated with Equation (5), column (5) reports estimates of δ_1 of Equation (8) with charges per provider as the dependent variable. For the moments associated with Equations (10) and (11), column (5) reports estimates of β_0 and β_1 , respectively, of Equation (9). For these estimates, an observation is a firm-month, and the standard errors are reported in parentheses and clustered by firm-size bin.

Figure 12: Equilibrium Outcomes by Firm Size



Notes: Equilibrium outcomes implied by parameters presented in Table 9. Panel (a) reports the unit cost of investment divided by the number of providers in the firm. Panel (b) reports the profit-maximizing monthly level of investment. For both of these panels, the units of investment are scaled so that one unit of investment induces a \$1 increase in charges per provider. Panel (c) reports the monthly per-provider cost of the profit-maximizing level of investment. Panel (d) reports the equilibrium monthly profit per provider. Note that the horizontal axes of all figures are spaced geometrically.

Table 9: Estimated Parameter Values

Parameter Estimate	
\underline{I}_0	1.55
\underline{I}_1	51.4
a	175
r	0.415
b	19,080
c	0.321
d	0.832
σ_π	75,744

Notes: Estimates of model parameters.

further credence to the validity of my model. For example, Sahni et al. (2021) estimate \$49.2 billion in total spending by physician groups on billing in 2019. The typical cost of staff and IT investments appear to be consistent with my estimates as well. For example, the median salary for a medical coder in 2022 is \$4,300 per month (Salary.com, 2022), while Fleming et al. (2011) estimate the cost to maintain an electronic health records system for a five-provider practice to be roughly \$7,125 per month. For larger hospitals and physician groups, though, the costs of investments in billing technology can be much, much larger. For example, upgrading their electronic health record system cost Partners HealthCare \$1.2 billion (McCluskey, 2015). In line with this, I estimate that for the largest providers in my data, billing costs can be over \$8 million per month.

In addition to estimating cross-sectional investment costs, the model allows me to quantify the costs of transitioning to a higher-denial administrator. For a solo practitioner, I estimate that raising administrative burdens induces \$325 of additional investment each month, lowering profits by 2.7%. For a firm containing the median number of providers, these figures are \$3,440 and 2.1%, respectively. For even the largest firms in my data, transitioning to a higher-denial administrator reduces profits by 2.0%. Scaling these estimates up, they imply that transitioning all providers from low- to high-denial administrators would induce \$4 billion in additional billing costs annually.

Furthermore, this estimate ignores the costs of administration to the insurers, which are likely to be substantial as well. CAQH (2014) uses a survey of private insurers to estimate that the cost of receiving and paying a claim manually is \$1.40 per claim and \$0.47 electronically, indicating a cost of \$85.6–254.9 million to process Medicare claims in 2017. Sahni et al. (2021) estimate administrative costs of \$260 billion in 2017 for private and public insurers. Furthermore, each Medicare Administrative Contractor contract is worth \$65 million annually on average, with an

estimated total cost of \$827.5 million in 2022.²⁹ Increasing administrative burden likely increases the costs to insurers as well.

8 Conclusion

Overall, these results highlight the negative consequences of administrative burdens in the health care sector. Using exogenous variation in the areas administered by each Medicare Administrative Contractor, I show that these contractors vary widely in their propensity to deny medical claims, with some administrators imposing much higher administrative burdens on health care providers than others. I then compare the reaction of providers to transitions between high- and low-denial contractors to show that increased burden leads to increased adoption of electronic health records and higher charges along with exit and consolidation. These responses negate the effect of more aggressive denials on overall Medicare spending. In fact, more aggressive denials on average promote higher health care spending. These results are consistent with a model of investment in billing technology that I estimate to show that the annual cost of complying with Medicare's billing rules is over \$30 billion. Overall, my results indicate that administrative burdens not only entail massive amounts of waste, but that they have negative consequences for the competitiveness of health care markets. Policymakers need to be cautious when imposing administrative burdens because as it stands now, administrative burdens do not achieve their goal of lowering health care spending and have the unintended consequence of increasing concentration among health care providers, indicating that administrative burdens are a lose-lose for the government, providers, and patients.

²⁹More details on the contracts awarded to by Medicare are available in Appendix A.

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A Medicare Administrative Contractor Contracts

Medicare Administrative Contractor contracts are awarded by competitive procurement auctions governed by Federal Acquisition Regulation. These regulations, along with the statutory guidelines for the contracts laid out in the Medicare Prescription Drug Improvement, and Modernization Act (MMA) of 2003 and revised by the Medicare Access and CHIP Reauthorization Act (MACRA) of 2015, stipulate the manner and frequency of contract awards as well as characteristics of the contracts themselves. Table A1 provides details on all Medicare Administrative Contractor contracts awarded under this framework. There have been 33 contracts awarded to 10 unique companies since 2006. The average contract is worth \$364 million and lasts between 5 and 7 years.³⁰ In total, the government has awarded contracts worth over \$12 billion.

These awards are not without controversy, with 15% of contracts (including 5 of the first 12) being protested by a losing party. In all cases, the contract was eventually awarded to initial winner.

These contracts have a cost-plus structure, meaning that administrators are reimbursed for their realized cost plus a potential bonus payment contingent on good performance. These bonus payments are made based on the contractor's performance relative to the Quality Assurance Surveillance Plan (QASP). For 2018 to 2020 (the only years for which data are available), the median QASP score ranged from 90-97% (CMS, 2021), indicating that these payments are generally made as a matter of course. The QASP entails multiple measures related to 11 performance areas of contractor performance, including customer service, Freedom of Information Act, and Debt Management. Claims processing and medical review are two of these categories. Most of the measures comprising these performance areas relate to timeliness while only one (medical review of claims and documentation) relates to claim rejection accuracy. This measure states "The contractor shall conduct medical review of claims submitted by providers or suppliers" and comprises only 1.3% of the overall QASP score. Thus contractors have little direct financial incentive to reject claims for medically unnecessary care.

In contrast, administrators do have a more indirect incentive to ensure that only appropriate care is reimbursed: keeping Medicare happy. The contracts are awarded via procurement auction, with quality being the primary measure. For example, one procurement request for proposal stipulated, "The Technical Approach evaluation factor and Past Performance evaluation factor are of equal importance. Technical Approach and Past Performance, when combined, are significantly more important than cost or price" (GSA, 2016). Because these contractors are playing a repeated game with the government, they have a strong incentive to pursue the government's goals, which in contrast to the QASP, depend heavily on the propriety of the claims paid and the

³⁰The MMA of 2003 stipulated that contracts had to be recompeted at least every 5 years, while MACRA raised this limit to 7 years.

overall financial impact on Medicare. For instance, CMS reported to Congress that contractors “will promote the fiscal integrity of Medicare and be accountable stewards of public funds. They will pay claims in a timely, accurate, and reliable manner while promoting cost efficiency and the delivery of maximum value to the customer” (CMS, 2005). Furthermore, CMS has the option to terminate MAC contracts early, although they have never done so as the necessary rebidding and transition process is seen as too costly (Levinson, 2014b).

Finally, one may wonder why the government contracts with private entities to administer Traditional Medicare rather than process claims itself. The answer, as it turns out, is largely political. When Medicare was created in the 1960s, opposition to perceived government control of doctors was very strong, and allowing private entities to stand between the government and providers was a way to mollify this opposition. In their history of Blue Cross and Blue Shield, Cunningham and Cunningham (1997) note, “Interposing...intermediaries was politically convenient because it insulated providers from direct contact with, and the threat of control by, the dreaded federal bureaucracy,” and the more contemporary account of Meyers (1970) argues, “[T]he requirement that it be administered with a third party (carriers) between physicians and the government, arose because of the strong views of the AMA (American Medical Association)...on the grounds that this involved governmental control and was socialized medicine.”

Table A1: Medicare Administrative Contractor Contracts

Estimated Value (\$millions)	Date Announced	Awardee	Jurisdiction	Length (Years)	Annual Value (\$millions)	Protested
192.0	7/31/2006	Noridian	3 (AZ, MT, ND, SD, UT, WY)	5	38.4	No
376.0	8/2/2007	TrailBlazer	4 (CO, NM, OK, TX)	5	75.2	No
225.0	9/5/2007	WPS	5 (IA, KS, MO, NE)	5	45.0	No
466.0	10/24/2007	Novitas	12 (NJ, PA, DE, DC, MD, NoVa)	5	93.2	Yes
358.0	10/25/2007	Palmetto	1 (AS, CA, GU, HI, NV, NMI)	5	71.6	Yes
323.0	3/18/2008	NGS	13 (CT, NY)	5	64.6	No
368.0	9/12/2008	FCSO	9 (FL, VI, PR)	5	73.6	No
176.0	11/19/2008	NHIC	14 (ME, MA, NH, RI, VT)	5	35.2	No
335.0	1/7/2009	Cahaba	J (TN, AL, GA)	5	67.0	No
304.5	5/21/2010	Palmetto	11 (SC, NC, VA, WV)	5	60.9	Yes
243.3	7/8/2010	CGS	15 (KY, OH)	5	48.7	Yes
218.0	8/22/2011	Noridian	F (AK, AZ, ID, MT, ND, OR, SD, UT, WA, WY)	5	43.6	No
218.0	9/30/2011	WPS	8 (IN, MI)	5	43.6	Yes
406.0	11/8/2011	Notivas	H (AR, CO, LA, MS, NM, OK, TX)	5	81.2	No
217.2	7/31/2012	WPS	5 (IA, KS, MO, NE)	5	43.4	No
404.1	9/17/2012	Novitas	L (NJ, PA, DE, DC, MD, NoVa)	5	80.8	No
345.2	9/20/2012	Noridian	E (AS, CA, GU, HI, NV, NMI)	5	69.0	No
318.0	9/27/2012	NGS	6 (IL, MN, WI)	5	63.6	No
493.2	2/22/2013	NGS	K (CT, ME, MA, NH, NY, RI, VT)	5	98.6	No
313.3	2/11/2014	FCSO	N (FL, VI, PR)	5	62.7	No
287.8	9/17/2014	Cahaba	J (TN, AL, GA)	5	57.6	No
394.8	4/1/2015	Palmetto	M (SC, NC, VA, WV)	5	79.0	No
246.3	9/17/2015	CGS	15 (KY, OH)	5	49.3	No
274.6	9/8/2017	Palmetto	J (TN, AL, GA)	5	54.9	No
313.5	7/12/2018	Noridian	F (AK, AZ, ID, MT, ND, OR, SD, UT, WA, WY)	7	44.8	No
282.2	11/1/2018	WPS	8 (IN, MI)	7	40.3	No
842.7	5/30/2019	Novitas	H (AR, CO, LA, MS, NM, OK, TX)	7	120.4	No
302.0	9/30/2019	WPS	5 (IA, KS, MO, NE)	7	43.1	No
432.9	7/15/2020	NGS	6 (IL, MN, WI)	7	61.8	No
556.8	12/18/2020	Noridian	E (AS, CA, GU, HI, NV, NMI)	7	79.5	No
669.3	7/27/2021	Novitas	L (NJ, PA, DE, DC, MD)	7	95.6	No
634.3	12/15/2021	NGS	K (CT, ME, MA, NH, NY, RI, VT)	7	90.6	No
476.5	4/27/2022	FCSO	N (FL, VI, PR)	7	68.1	No

Notes: Data collected from <https://www.cms.gov/Medicare/Medicare-Contracting/Medicare-Administrative-Contractors/Who-are-the-MACs>. Jurisdiction reports the name of the jurisdiction at the time of contract award along with the states that comprise the jurisdiction. Note that claims from northern Virginia are always processed by the same Medicare Administrative Contractor that processes claims for DC. Length reports the maximum length of the contract when awarded. This always consists of one base year and 4 or 6 option years. Protested indicates the award announcement notes that the contract award was protested by another bidder.

B Alternative Measures of Administrative Burden

In this appendix, I report results using alternative measures of administrative burden. The measure used in the main text is the share of claims that are denied. The alternative measures reported here are the share of claim lines that are denied, the share of charges on denied claims, and the share of charges on denied claim lines.

I first report estimates of the causal effect of each administrator on each of these outcomes. The ranking of the administrators using these alternative measures of administrative burden are quite similar to that obtained using my primary measure, as shown in Table A2. The correlation between the estimated effect of each administrator on each of these alternative measures and the estimated effect on the claim denial rate is reported in the table below the point estimates. These correlations range from 0.58 to 0.81, indicating they are all strongly correlated.

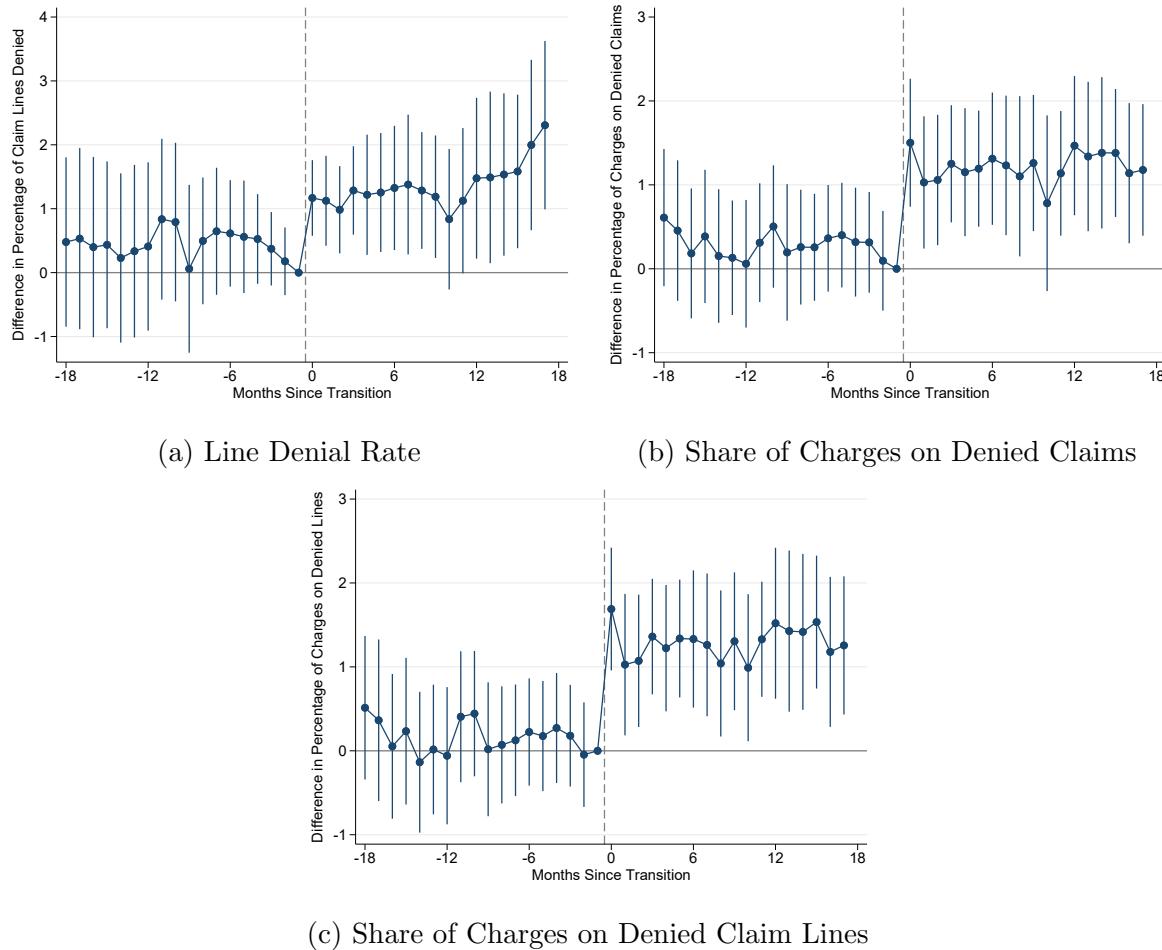
To further validate my measure of administrative burden, I next demonstrate that transitions between low- and high-denial administrators along this measure capture meaningful changes along the alternative measures as well. Figure A1 presents the estimated differential change in each alternative measure of administrative burden following a transition to an administrator with a lower estimated impact on the claim denial rate to one with a lower estimated effect relative to a transition to a lower-denial administrator. Across all measures of administrative burden, a transition to an administrator that imposes greater burdens according to my primary measure is associated with a similar increase in the alternative measure of burden, again indicating that I am capturing meaningful differences across administrators in the burdens they impose.

Table A2: Estimated Effect of Each Contractor on Alternative Measures of Administrative Burden

	(1)	(2)		(3)	
	Line Denial Rate	Share of Charges on Denied Claims	Share of Charges on Denied Claim Lines	Share of Charges on Denied Claims	Share of Charges on Denied Claim Lines
Metra	1.542	1.32	1.779	0.72	1.532
Nationwide	0.147	1.281	1.199	0.467	0.629
Group Health	3.447	1.127	1.244	0.627	1.626
Triple-S	6.353	1.284	-2.626	0.636	-1.185
Pinnacle	-0.869	1.338	-0.091	0.512	-0.552
BCBSRI	-1.794	1.644	-0.838	0.606	-1.635
Wheatlands	0.37	1.614	0.0712	0.493	-0.0766
TrailBlazer	-0.983	1.263	-0.0162	0.495	-0.281
NHIC	0.768	1.131	-0.112	0.541	-0.351
NGS	-1.259	1.088	-0.0301	0.552	-0.458
Novitas	-1.405	1.389	-0.288	0.541	-0.94
WPS	0.797	1.238	-0.299	0.486	-0.454
Palmetto	-1.473	0.866	-0.321	0.355	-0.649
HealthNow	-2.652	1.157	-0.447	0.58	-0.683
FCSO	-0.681	1.096	-0.921	0.531	-1.202
Cahaba	-1.704	1.593	-0.923	1.048	-1.475
CGS	-1.34	1.007	-1.09	0.581	-1.256
BCBSMT	-0.0639	0.4	-2.567	0.205	-2.348
Regence	-2.168	0.418	-0.887	0.374	0.00739
TOLIC	-4.079	1.496	-4.761	0.859	-4.312
Correlation with Main Estimate	0.5802		0.8052		0.7662
Demographic Controls	Yes		Yes		Yes
Month Fixed Effects	Yes		Yes		Yes
Jurisdiction Fixed Effects	Yes		Yes		Yes
Jurisdiction-Specific Trend	Yes		Yes		Yes
Dep. Var. Mean	13.65		6.174		8.078
R ²	0.906		0.778		0.816
Observations	12,996		12,996		12,996

Notes: Estimates of γ_m of Equation (1). Note that coefficient estimates are reported in the same order as in Table 3. An observation is a jurisdiction-month. The excluded contractor is Noridian. Dependent variables are given by the column title. Standard errors are reported to the right of the point estimates and clustered by jurisdiction. +, *, ** and *** indicate significance at the 10%, 5%, 1% and 0.1% level, respectively.

Figure A1: Estimated Effect of Transition on Alternative Measures of Administrative Burden



Notes: Estimates of δ_e of Equation (2) for $e \in \{-18, \dots, 17\}$. An observation is a jurisdiction-wave-month. Dependent variables are given by the caption to each subfigure. Error bars give the 95% confidence interval for each estimate. Standard errors are clustered by jurisdiction.

C Estimated Fixed Effects with Alternative Jurisdiction-Specific Trends

In this appendix, I present estimates of the effect of each contractor on the denial rate allowing for more or less flexible jurisdiction-specific trends. The main estimates presented in Table 3 allow each jurisdiction to have an arbitrary mean denial rate and jurisdiction-specific linear trend. In column (1) of Table A3, I present estimates allowing each jurisdiction to have its own mean denial rate but restrict all jurisdictions to have common trends. That is, I estimate the following equation:

$$(12) \quad Y_{jmt} = \mu_m + \Gamma X_{jt} + \alpha_{0j} + \eta_t + \varepsilon_{jmt},$$

In column (2) I present estimates allowing each jurisdiction to have a quadratic jurisdiction-specific trend, or estimates of the following equation:

$$(13) \quad Y_{jmt} = \mu_m + \Gamma X_{jt} + \alpha_{0j} + \alpha_{1j}t + \alpha_{2j}t^2 + \eta_t + \varepsilon_{jmt},$$

The correlation of each of these alternative estimates with those presented in Table 3—along with the lack of differential pre-trends shown in Figure 4—indicate that my results are unlikely to be driven by slow-moving differential trends across jurisdictions.

Table A3: Estimated Effect of Each Contractor on Denial Rates with Alternative Jurisdiction-Specific Trends

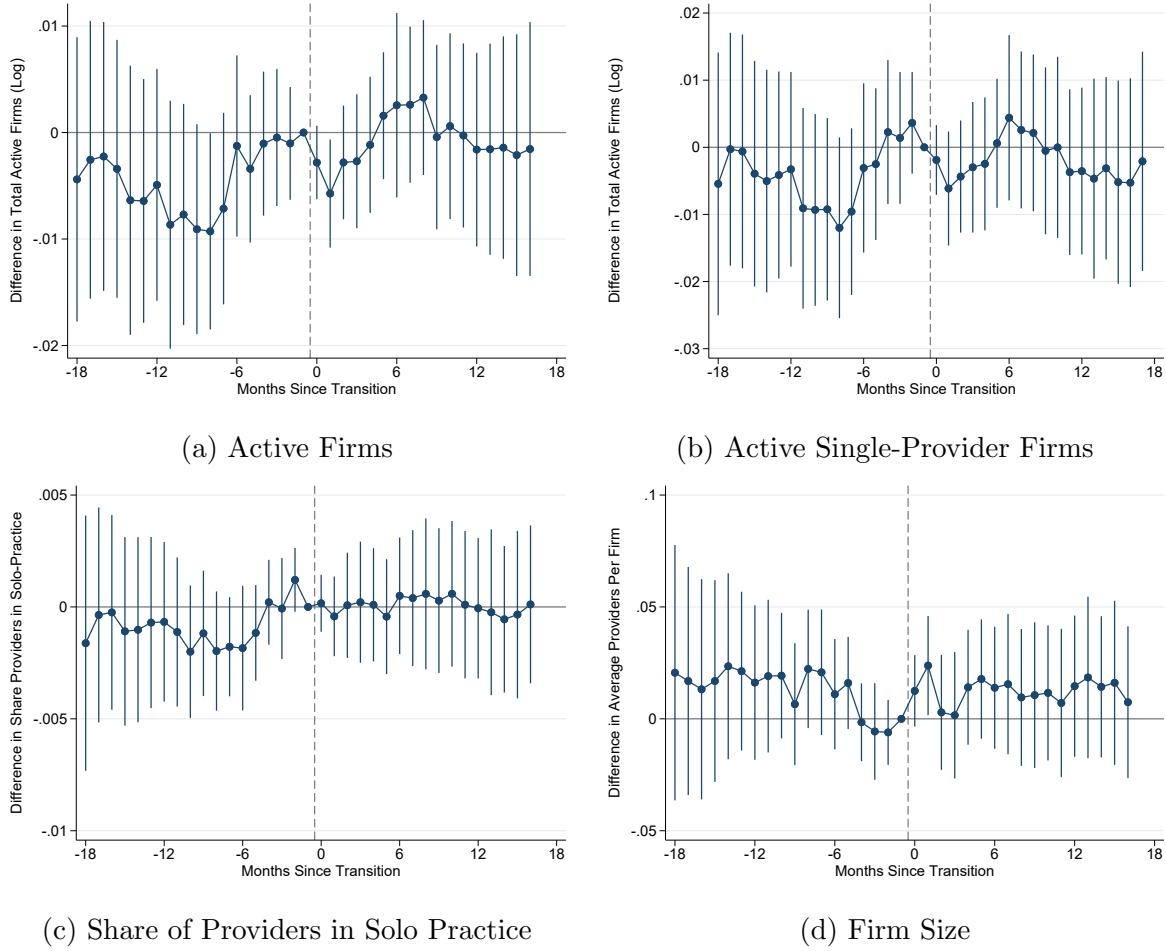
	(1)	(2)		
	Denial Rate	Denial Rate	Denial Rate	
Metra	2.990***	0.542	0.125	0.618
Nationwide	0.201	0.382	-0.716*	0.349
Group Health	-0.104	0.680	0.677	0.475
Triple-S	1.228	0.761	0.167	0.478
Pinnacle	-0.0836	0.424	0.289	0.421
BCBSRI	1.065**	0.411	-0.654	0.574
Wheatlands	-0.956*	0.395	0.476	0.496
TrailBlazer	-0.152	0.317	0.0741	0.291
NHIC	-0.244	0.418	-0.105	0.349
NGS	-0.630 ⁺	0.336	-0.00680	0.383
Novitas	0.228	0.353	0.109	0.325
WPS	-0.160	0.372	-0.0531	0.416
Palmetto	-0.419	0.277	-0.776 ***	0.215
HealthNow	-0.0298	0.385	-0.427	0.443
FCSO	-0.108	0.436	-0.970*	0.401
Cahaba	-0.216	0.391	-0.364	0.540
CGS	0.250	0.258	-0.956**	0.315
BCBSMT	-0.626**	0.200	-1.758***	0.152
Regence	-1.426***	0.270	-0.413*	0.207
TOLIC	-3.036***	0.557	-2.902***	0.463
Correlation with Main Estimate		0.7974	0.7697	
Demographic Controls		Yes	Yes	
Month Fixed Effects		Yes	Yes	
Jurisdiction Fixed Effects		Yes	Yes	
Jurisdiction-Specific Linear Trend		No	Yes	
Jurisdiction-Specific Quadratic Trend		No	Yes	
Dep. Var. Mean	6.360		6.360	
R ²	0.730		0.844	
Observations	12,996		12,996	

Notes: Estimates of γ_m from Equation (12) are reported in column (1) and Equation (13) are reported in column (2). Note that coefficient estimates are reported in the same order as in Table 3. An observation is a jurisdiction-month. The excluded Contractor is Noridian. Dependent variable is the share of claims denied. Standard errors are reported to the right of the point estimates and clustered by jurisdiction. +, *, ** and *** indicate significance at the 10%, 5%, 1% and 0.1% level, respectively.

D Other Consequences of Increasing Administrative Burden

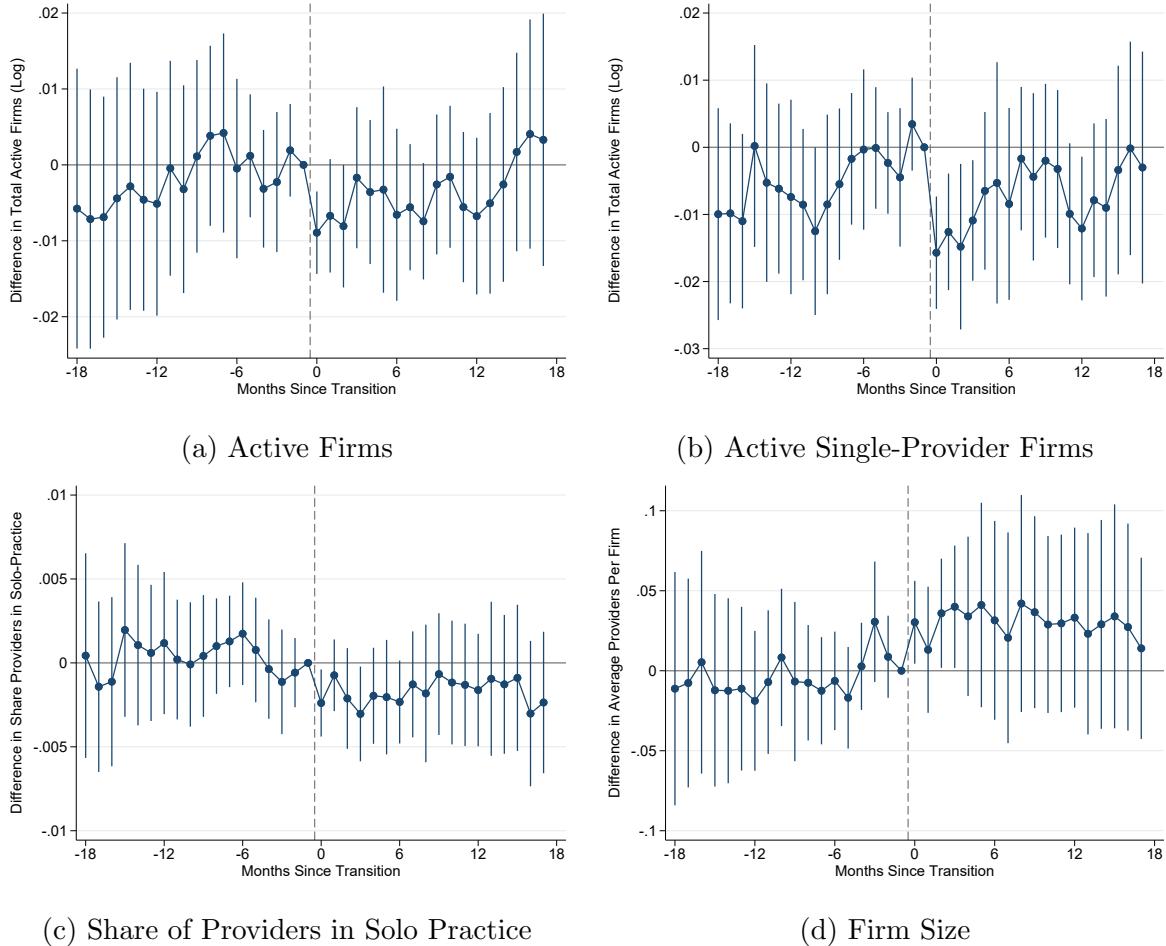
In this appendix, I report additional results on the responses of providers to changes in their Medicare Administrative Contractor. Figure A2 reports how market structure changes following a transition to a lower-denial administrator while Figure A3 reports estimates of the triple-difference specification comparing the changes following transitions to higher- and lower-denial administrators. Figure A4 and Table A4 report evidence that beneficiary mortality does not change following transitions.

Figure A2: Effect of Transitions to Lower-Denial Administrators on Market Structure



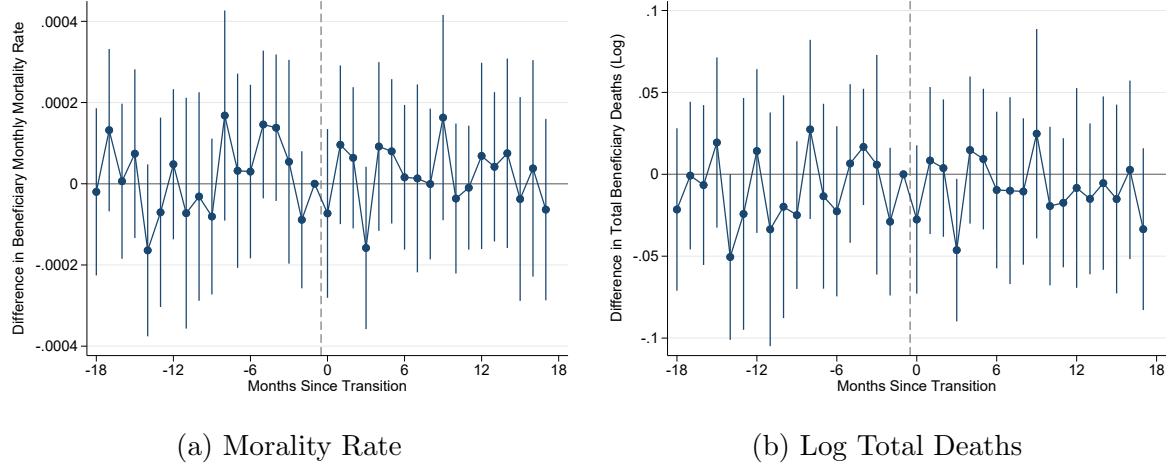
Notes: Estimates of β_e of Equation (3) for $e \in \{-18, \dots, 17\}$. An observation is a jurisdiction-wave-month. The sample is limited to transitions to a lower-denial administrator and appropriate control jurisdictions. Dependent variables are the number of active firms and the number of single-provider active firms (both in logs), the share of providers affiliated with single-provider firms, and the firm-level average number of providers per firm. Error bars give the 95% confidence interval for each estimate. Standard errors are clustered by jurisdiction.

Figure A3: Differential Effect of Transitions to Higher-Denial Administrators on Market Structure



Notes: Estimates of δ_e of Equation (2) for $e \in \{-18, \dots, 17\}$. An observation is a jurisdiction-wave-month. Dependent variables are the number of active firms and the number of single-provider active firms (both in logs), the share of providers affiliated with single-provider firms, and the firm-level average number of providers per firm. Error bars give the 95% confidence interval for each estimate. Standard errors are clustered by jurisdiction.

Figure A4: Effect of Transition to Higher-Denial Administrator on Mortality



Notes: Estimates of δ_e of Equation (2) for $e \in \{-18, \dots, 17\}$. An observation is a jurisdiction-wave-month. Dependent variables are total monthly deaths of Medicare enrollees per Medicare beneficiary and in logs. Error bars give the 95% confidence interval for each estimate. Standard errors are clustered by jurisdiction.

Table A4: Effect of Higher-Denial Administrator on Mortality

	(1)	(2)
	Mortality (per capita)	Mortality (log)
Post-Transition	-0.00000596 (0.0000234)	-0.00513 (0.00622)
Increase in Denials	0.00000369 (0.0000438)	0.000137 (0.00985)
Dep. Var. Mean	0.00431	5.741
Observations	70,164	70,164

Notes: Estimates of δ_1 of Equation (8) with $L = 17$. An observation is a jurisdiction-wave-month. Dependent variables are total monthly deaths of Medicare enrollees per Medicare beneficiary and in logs. Standard errors are clustered by jurisdiction. +, *, ** and *** indicate significance at the 10%, 5%, 1% and 0.1% level, respectively.

E Low-Value Care

One area in which providers and claims processors may interact differently are claims for low-value care. Much of the health care provided in the US is thought to be of very low value, with Fisher et al. (2003a,b) estimating roughly 30% Medicare spending results in no improvements in health. This wasteful resource use can come from a variety of sources, including physicians persisting in providing care that is rarely if ever cost-effective (Chandra et al., 2011) or physicians making errors in determining which patients are suitable for which treatments (Mullainathan and Obermeyer, 2022). Utilization of these low-value treatments vary especially widely, with local practice styles differing in their embrace of these treatments (Skinner, 2011). This variation in utilization of potentially low-value treatments has been known for at least 80 years since Glover (1938) highlighted the differences in tonsillectomy rates across Britain.

The geographic variation in the utilization of low-value procedures represents a setting for which the decentralized administrative structure of Medicare may pose an advantage. Indeed, a recent MedPAC report argues that having multiple regional administrators is advantageous for reacting to “regional differences, which the agency considers to be a fundamental characteristic of local coverage” (MedPAC, 2018). Furthermore, while administrative burdens may often impose needless costs, erecting barriers to providers’ ability to supply unnecessary and wasteful care can be welfare enhancing (Zeckhauser, 2021).

To assess this possibility I estimate the effect of each contractor on the probability of denying each of 7 different low-value services, and investigate provider responses to changes in the denial rates for these services. The low-value services I use come from Schwartz et al. (2014) and include cervical and colorectal cancer screenings for elderly patients, carotid artery disease screening, prostate-specific antigen testing in elderly men, homocysteine testing, carotid endarterectomy, and inferior vena cava filter placement. In future versions of paper, I hope to incorporate more instances of low-value care, including the 19 other services highlighted by Schwartz et al. (2014).

Table A5 reports the mean denial and utilization rates for these services in my data, along with the range of estimates of the causal effect of each contractor on the denial rate for these procedures and the correlation of these estimated causal effects with the estimated effect on denial rates reported in Table 3. These results indicate that differences across administrators in their propensity to deny claims for these low-value services vary even more widely than their overall propensity to deny claims. Furthermore, these effects are generally positively correlated with the overall administrator effects on denials, indicating that contractors that impose high administrative burdens in general do the same for low-value care.

The low-value service with the widest range of estimated fixed effects is homocysteine testing, for which the estimated range is over three times the mean denial rate. Figure A5 reports event study estimates for transitions from an administrator with a lower propensity to deny these

Table A5: Summary Statistics for Low-Value Care

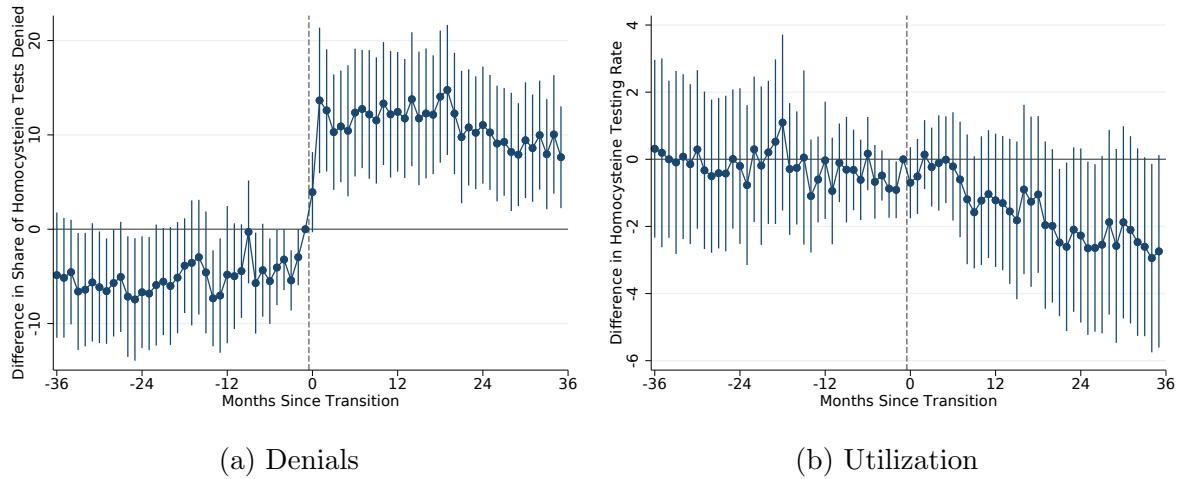
Service	Denial Rate	Utilization Rate	Effect Range	Standard Error	Correlation
Cervical Cancer Screening	26.3	16.9	22.2***	2.75	0.20
Colorectal Cancer Screening	12.0	15.9	22.1***	4.45	-0.20
PSA Testing	18.2	30.0	21.8***	6.35	0.63**
Homocysteine Testing	13.5	9.92	37.7***	9.42	0.37 ⁺
CAD Screening	15.1	8.96	24.0***	3.48	0.47*
Endartectomy	4.37	0.250	11.0***	1.91	0.34
IVC Filter Placement	6.27	0.084	13.2***	2.76	0.39 ⁺

Notes: Denial rate reported is the jurisdiction-month-level average share of claims for the service denied. Utilization rate reported is the jurisdiction-month-level average number of uses per 1000 eligible beneficiaries. Effect range is the difference between the largest and smallest estimate of γ_m of Equation (1) with the denial rate for the relevant service as the dependent variable. The standard error of this range is given by a Z-test of equality of the coefficients. Correlation reports is the contractor-level correlation between the estimates of γ_m of Equation (1) with the denial rate for the relevant service as the dependent variable and the estimates reported in Table 3. Standard errors are clustered by jurisdiction. ⁺, *, ** and *** indicate significance at the 10%, 5%, 1% and 0.1% level, respectively.

claims to a higher one. We see that these transitions result in very large and immediate changes in the denial rate for this low-value procedure. In contrast with the response to the overall denial rate, the jump in denial rates for this service results in decreased use over time.

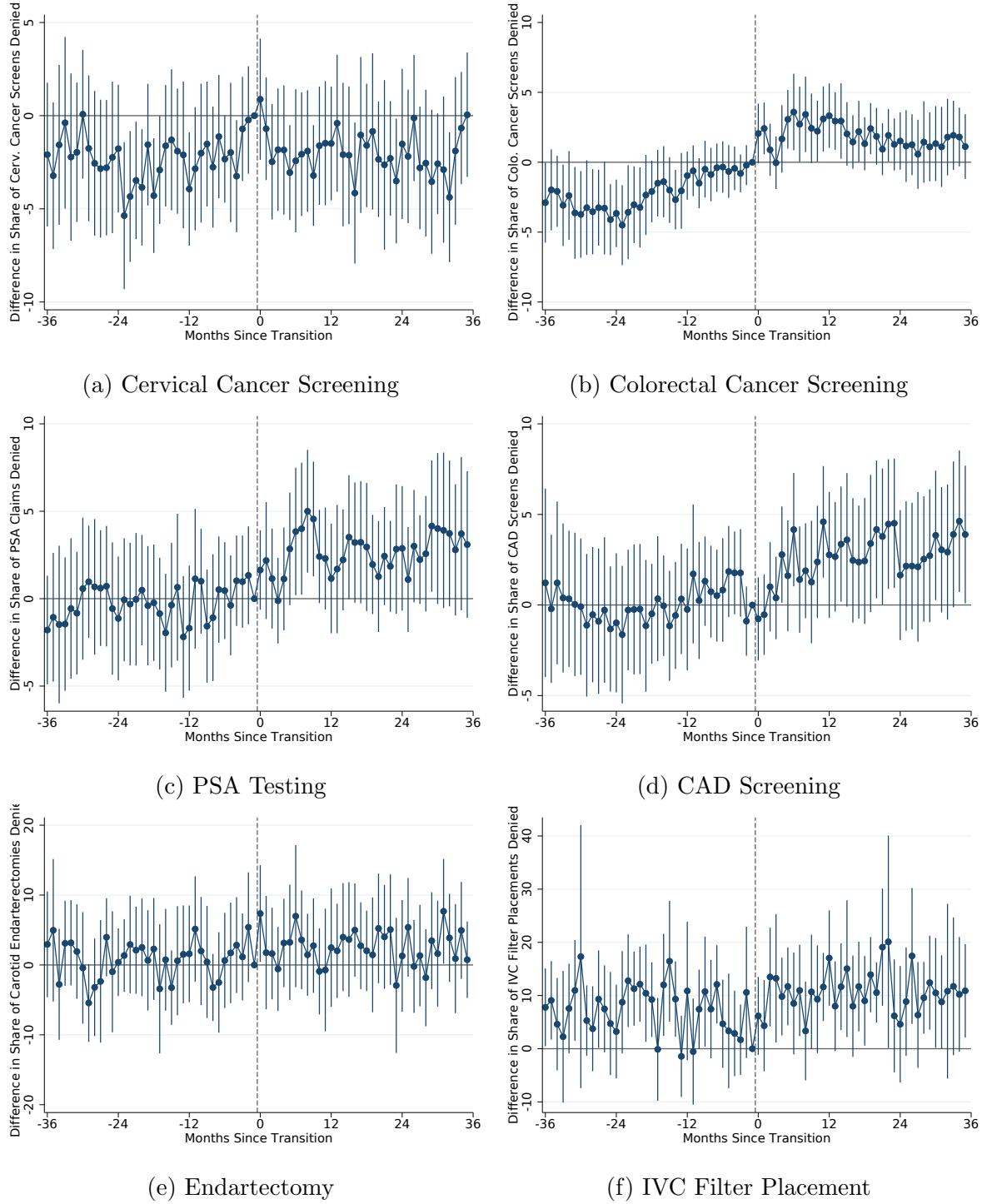
Figures A6 and A7 report similar event study estimates for the other six types of low-value care. First, we see that for some services transitions resulted in negligible denial rate changes while for others—including colorectal cancer screenings, PSA testing, and CAD screening—the changes were smaller but still notable. Nonetheless, for none of these services does utilization respond. This is consistent with providers only being willing to dramatically change practice patterns for a given procedure in response to large changes in the denial rate. In fact, even relatively large changes in denial rates often represent much smaller changes in provider revenue. For example, while the roughly 20 percentage point change in denial rates observed for homocysteine testing represents a drop in expected revenue of 23% relative to the mean denial rate, the 1 percentage point change in overall denial rates reported in Figure 4 represents a 16% change in the denial rate but only a 1% reduction in revenue. These results indicate that minor changes to the denial rate for a procedure are unlikely to affect the use of that procedure, meaning that denials are unlikely to steer providers toward high-value care.

Figure A5: Effect of Transition to Higher-Denial Administrator on Homocysteine Testing



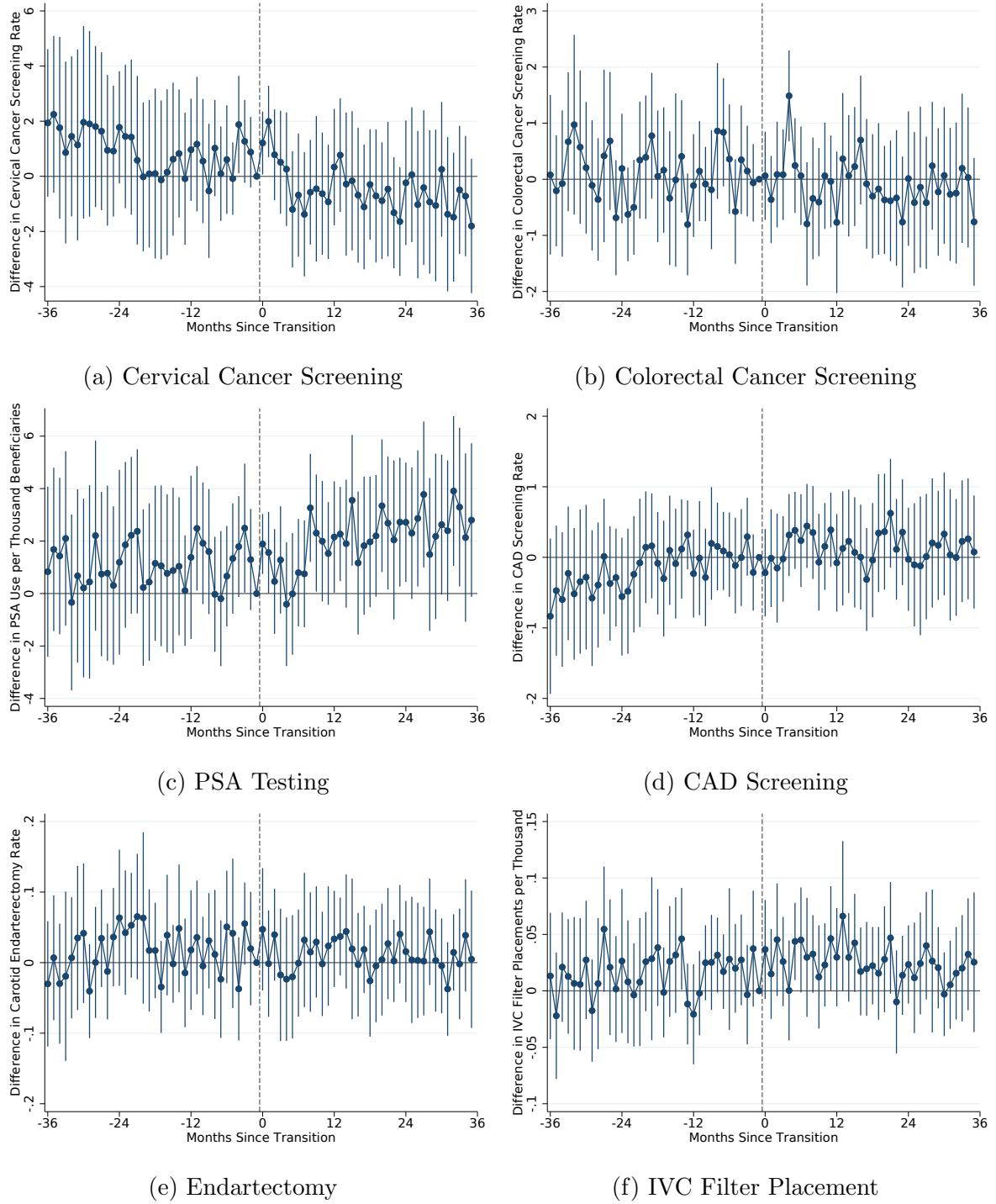
Notes: Estimates of β_e of Equation (2) for $e \in \{-36, \dots, 35\}$. An observation is a jurisdiction-wave-month. Dependent variables are the share of claims for homocysteine testing denied and the number of claims for homocysteine testing per 1,000 beneficiaries. Error bars give the 95% confidence interval for each estimate. Standard errors are clustered by jurisdiction.

Figure A6: Effect of Transition to Higher-Denial Administrator on Denials of Low-Value Services



Notes: Estimates of β_e of Equation (2) for $e \in \{-36, \dots, 35\}$. An observation is a jurisdiction-wave-month. Dependent variables are the share of claims for various types of low-value care denied. Error bars give the 95% confidence interval for each estimate. Standard errors are clustered by jurisdiction.

Figure A7: Effect of Transition to Higher-Denial Administrator on Utilization of Low-Value Services



Notes: Estimates of β_e of Equation (2) for $e \in \{-36, \dots, 35\}$. An observation is a jurisdiction-wave-month. Dependent variables are the number of claims per 1,000 beneficiaries for various types of low-value care. Error bars give the 95% confidence interval for each estimate. Standard errors are clustered by jurisdiction.

F Validating Estimation Results

In this appendix, I provide evidence that my model estimates successfully fit the data well. First, I present evidence that the model is able to closely match observed the relationship between firm size and the denial rate. Table A6 reports estimates of Equation (9) with different weighting schemes along with the values implied by the model estimates reported in Section 7 using both the high and low administrative burden estimates of \underline{I} as well as the average level of burden used in the estimation. Notice the concordance between these estimates and those predicted by the model. Figure A8 similarly presents the transformed and untransformed relationships between denial rate and firm size predicted by the model and observed in the data. Both the table and figure indicate that the predictions of the model closely match those of the data.

Table A6: Relationship Between Squared Denial Rate and Inverse Firm Size

	Observed		Predicted		
	(1)	(2)	(3)	(4)	(5)
	Denial Rate ²				
Inverse Firm Size	33.91 (2.338)	37.91 (2.254)	29.75	38.15	33.95
Constant	44.16 (2.495)	37.91 (0.5573)	38.67	49.59	44.13
\underline{I}			\underline{I}_0	\underline{I}_1	$\frac{\underline{I}_0 + \underline{I}_1}{2}$
Weighting	Firms	Providers			
Dep. Var. Mean	71.05	50.87			
Observations	61,725,317	199,100,356			

Notes: Estimates of β_0 and β_1 of Equation (9). An observation is a firm-month. Firm size is determined by the number of providers in a jurisdiction billing under the same tax identification number. All estimates are scaled to have the denial rate be between 0 and 100. Observations are frequency-weighted by the number of firms in column (1) and providers associated with the firm in column (2). Standard errors are clustered by firm-size. Columns (3), (4), and (5) report predicted values using the estimates reported in Table 9.

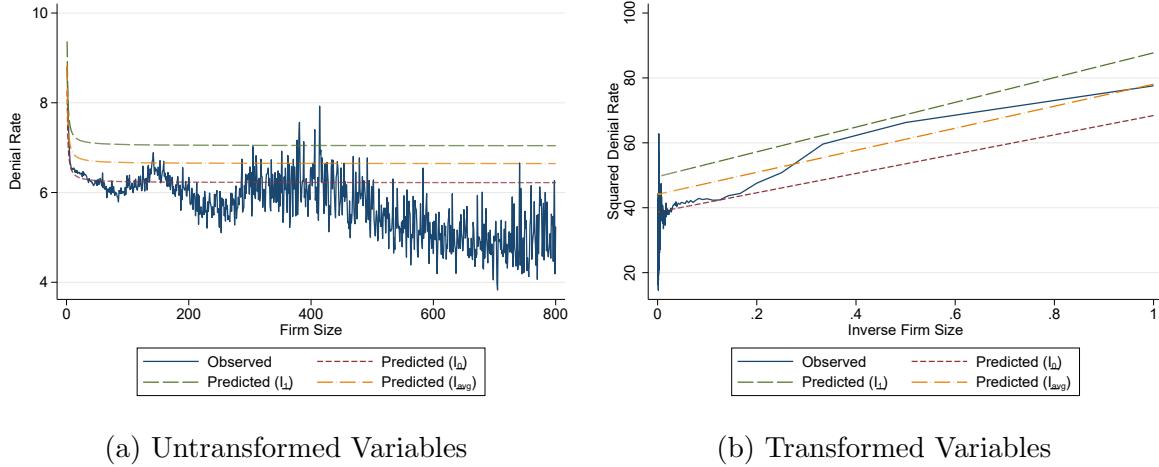
Next, I compare the predicted responses of equilibrium outcomes to a change in administrative burden that come out of the model to those observed in the data. Table A7 presents the estimated and predicted change in charges, denials, and active firms corresponding to the moments used in estimation. Note that columns (1)–(5) of the table are identical to Table 8, while column (6) reports the corresponding predictions of the estimated model. As shown in column (7), for none of these moments is the predicted change different from the observed change in a statistically significant way, indicating good model fit.

Table A7: Estimated and Predicted Responses to Changes in Administrative Burden

(1) Moment Equation	(2) Firm Sizes	(3) Estimand	(4) Structural Parameter	(5) Estimate	(6) Model Prediction	(7) P-Value
Equation (7)	1	$\frac{N_{v_{j1}}}{N_{v_{j0}}}$	$\frac{1-\Phi\left(\frac{-\Pi_{ij1}}{\sigma_\pi}\right)}{1-\Phi\left(\frac{-\Pi_{ij0}}{\sigma_\pi}\right)}$	0.99614 (0.00711)	0.99614	1.000
Equation (6)	1	$\mathbb{E}[\tilde{P}_{ij1}] - \mathbb{E}[\tilde{P}_{ij0}]$	$\sqrt{\frac{c+d-r}{b-ar}}\Delta$	-0.01093 (0.00261)	-0.01095	0.993
Equation (6)	2–5	$\mathbb{E}[\tilde{P}_{ij1}] - \mathbb{E}[\tilde{P}_{ij0}]$	$\sqrt{\frac{c+(d-r)3.0424099}{3.0424099(b-ar)}}\Delta$	-0.01089 (0.00261)	-0.00922	0.522
Equation (6)	6–21	$\mathbb{E}[\tilde{P}_{ij1}] - \mathbb{E}[\tilde{P}_{ij0}]$	$\sqrt{\frac{c+(d-r)11.7714}{11.7714(b-ar)}}\Delta$	-0.00832 (0.00245)	-0.00850	0.942
Equation (6)	22–104	$\mathbb{E}[\tilde{P}_{ij1}] - \mathbb{E}[\tilde{P}_{ij0}]$	$\sqrt{\frac{c+(d-r)49.764092}{49.764092(b-ar)}}\Delta$	-0.00940 (0.00249)	-0.00830	0.658
Equation (6)	≥ 104	$\mathbb{E}[\tilde{P}_{ij1}] - \mathbb{E}[\tilde{P}_{ij0}]$	$\sqrt{\frac{c+(d-r)517.64321}{517.64321(b-ar)}}\Delta$	-0.00460 (0.00295)	-0.00824	0.217
Equation (5)	All	$\mathbb{E}[\tilde{R}_{ij1}] - \mathbb{E}[\tilde{R}_{ij0}]$	$-r\sqrt{\frac{v(b-ar)}{c+(d-r)v}}\Delta$	140.2 (70.64)	140.2	1.000
Equation (10)	All	β_0	$\frac{(a+I_{avg})(d-r)}{b-ar}$	44.16 (2.50)	44.13	0.990
Equation (11)	All	β_1	$\frac{(a+I_{avg})c}{b-ar}$	33.91 (2.34)	33.95	0.988

Notes: Column (1) reports the equation that defines the moment to be estimated. Column (2) reports the number of providers associated with the firms to which the estimation sample is limited. Columns (3) and (4) report the estimand associated with the moment and the combination of structural parameters to which it is equivalent. Note that $\Delta \equiv \sqrt{a+I_0} - \sqrt{a+I_1}$ and $I_{avg} \equiv \frac{I_0+I_1}{2}$. For the moment associated with Equation (7), column (5) reports estimates of $\delta_1 + 1$ of Equation (8) with log number of active firms as the dependent variable. For the moments associated with Equation (6), column (5) reports estimates of $-\delta_1$ of Equation (8) with share of claims denied as the dependent variable. For these estimates, an observation is a jurisdiction-wave-month-quintile, and the standard errors are reported in parentheses and clustered by jurisdiction. For the moment associated with Equation (5), column (5) reports estimates of δ_1 of Equation (8) with charges per provider as the dependent variable. For the moments associated with Equations (10) and (11), column (5) reports estimates of β_0 and β_1 , respectively, of Equation (9). For these estimates, an observation is a firm-month, and the standard errors are reported in parentheses and clustered by firm-size. Column (6) reports the predictions of the model using the parameters reported in Table 9. Column (7) reports the p-value of the observed estimate reported in column (5) under the null hypothesis that the model prediction reported in Column (6) is correct.

Figure A8: Relationship Between Firm Size and Denial Rate, Observed and Predicted



Notes: Figure reports the observed and predicted average denial rate by firm size for firms with up to 800 providers. An observation is a firm-month. Firm size is determined by the number of providers in a jurisdiction billing under the same tax identification number. Predictions are generated using parameter estimates reported in Table 9.

Finally, one relationship predicted by the model but not directly used in estimation is the relationship between the percentage change in denial rate and the level of administrative burden. Recall that the predicted change in payment rate for a change from I_0 to I_1 is

$$\mathbb{E}[\tilde{P}_{ij1}] - \mathbb{E}[\tilde{P}_{ij0}] = \sqrt{\frac{c + (d - r)v}{v(b - ar)}} \left(\sqrt{a + I_0} - \sqrt{a + I_1} \right).$$

This means that the expected percent change in denial rate is given by

$$\frac{\left(1 - \mathbb{E}[\tilde{P}_{ij1}]\right) - \left(1 - \mathbb{E}[\tilde{P}_{ij0}]\right)}{\left(1 - \mathbb{E}[\tilde{P}_{ij0}]\right)} = \sqrt{\frac{a + I_1}{a + I_0}} - 1.$$

Using the estimated model parameters, the predicted value of this object is 0.132. This is quite close to—and not statistically different from—the observed change in log denial rate for transitions from low- to high-denial administrators: 0.118 with a standard error of 0.0245.

Thus comparing the predictions of the model to the observed relationships indicate that the model is matches the data well, lending support to the validity of the model and my estimates.