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HOSPITAL INFLUENCE ON PHYSICIAN BEHAVIORS

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ABSTRACT

The organizational structure of U.S. health care markets has changed dramatically in recent years, with nearly half of physicians now employed by hospitals. This trend toward increasing vertical alignment between physicians and hospitals may alter physician behavior relative to physicians remaining in independent or group practices. We examine the effects of such vertical alignment using an instrumental variable strategy and a clinical context facilitating well-defined episodes of care in order to capture effects of integration beyond a single hospital or physician visit. When physicians treat patients at hospitals in which they are integrated, we find increases in total episode spending of around 5%, primarily driven by the administrative substitution of office visits with outpatient visits and associated site-of-care payment differentials. We also estimate a large and statistically significant reduction in overall service counts and claims within an episode, with some evidence of an increase in the intensity of services provided. Ultimately, acquiring hospitals capture more revenue following a physician practice acquisition; yet, the smaller overall bundle of care generates no net savings to Medicare due partly to higher intensity of services as well as site-based payment rules favorable to hospitals.

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GitHub Replication Files are available at https://github.com/imccart/physician-hospital-VI

1 Introduction

Hospital and physician services constitute the two largest components of U.S. health expenditures and jointly accounted for over $2.2 trillion in U.S. health spending in 2022 (50% of total health expenditures). Physicians also serve as gatekeepers for hospital-based services by referring patients to specific providers, leaving hospitals with clear incentives to influence physician behavior where possible to improve profitability (Gaynor & Town, 2012; Gaynor *et al.*, 2015; Post *et al.*, 2018). The opportunity for hospitals to influence treatment patterns of physicians also exists so long as patients remain at an informational disadvantage and insurer monitoring of physician decisions is incomplete.[1] Hospitals therefore have both the opportunity and financial incentive to influence physician behaviors toward their own objectives, with potential implications for pricing, competitiveness, spending, and utilization. This paper aims to quantify hospitals' influence on physician behaviors in the context of well-defined episodes of care initiated by an elective inpatient surgery. We consider hospital acquisitions of physician practices as movement toward greater monitoring and control by hospitals and possibly improved incentive alignment between hospitals and physicians.

Traditional physician-hospital relationships rely heavily on informal arrangements and often incomplete incentive alignment, thereby limiting a hospital's direct control over its revenue streams. Acquisition of physician practices may serve as a way for hospitals to gain more influence over physician behaviors. For example, following integration, hospitals become the residual claimant for malleable income streams that are strongly shaped by physician decision-making, including physicians' directly provided services, complementary services (e.g., diagnostic tests), and referrals to other providers owned by the hospital (Kocher & Sahni, 2011). Indirectly, hospitals may also influence physician referrals to other non-integrated providers. The ability of the hospital to profitably influence these separate, but interdependent sources of revenue will depend on the amount of control that can be exercised over the newly acquired practice.

Conversely, organizational structure is known to influence physician effort and revenue generation. Economists have long recognized the inherent trade-off between risk-spreading and incentivizing individual physician output when forming groups (Gaynor & Gertler, 1995). In the context of practice acquisitions, vertical integration could disincentivize physician effort (i.e., billable activity) by joining the affected physician with a larger group of other hospital-employed physicians and di-

[1]See Wennberg & Gittelsohn (1973), Skinner & Fisher (1997), Wennberg *et al.* (2004), Baicker & Chandra (2004), and Gottlieb *et al.* (2010), among others, for studies of geographic variation in health care utilization. More recently, Finkelstein *et al.* (2016) exploits patient migration to estimate that 50-60% of geographic variation in spending is due to supply-side factors. Molitor (2018) likewise uses cardiologists' migration patterns to show that 60-80% of the variation in treatment styles can be explained by characteristics of the local physician practice.

minishing the financial incentives tied to ownership of a practice,[2] as Post *et al.* (2023) find in their study of newly acquired primary care physicians. It is therefore an open empirical question as to how these different and potentially countervailing forces shape overall treatment intensity and spending.

Our analysis allows us to decompose the effects of vertical integration on physician behaviors into multiple dimensions. We accomplish this by adopting more comprehensive measures of spending and utilization than what are found in the most closely related literature. Specifically, our analysis examines usage across all facilities, providers, and care settings within a given time horizon (i.e., an "episode of care"), including all spending and utilization related to inpatient, outpatient, skilled nursing facility (SNF), home health, and professional services. Each episode is initiated by a planned and elective inpatient procedure and encompasses claims up to 30 days prior and 90 days after the inpatient stay. Our episode-based outcomes capture both mechanical changes (e.g., increases in outpatient facility spending due to site-of-care payment differentials, as has been well-studied in the literature) as well as changes in professional services and other care related to referral decisions once physicians transition from being practice owners to hospital employees. Importantly, in subsequent analyses of different components of an episode, we present evidence that our estimates are not fully explained by mechanical changes but instead reflect a behavioral response of physicians to integration with hospitals.

Our theoretical framework considers an episode of care that is initiated by a physician/hospital pair, in consultation with the patient. The physician and hospital then maintain some influence on treatment patterns throughout the episode (e.g., follow-up visits, testing, or related consultations), even if care is not delivered at the same hospital or by the same physician. For example, the operating physician, as the focal provider in such a clinical context, would typically dictate the pre-operative care and post-operative discharge plan, guiding the patient on necessary follow-up care. The operating physician is also likely to advise the patient on the timing and frequency of follow-up care, either delivered by the operating physician or other providers.

Our main empirical analysis is based on a 20% random sample of Medicare fee-for-service (FFS) beneficiaries from 2010 to 2015, for which we observe all Parts A and B Medicare claims. As discussed in more detail in Section 3 and the supplemental appendix, our final analytic dataset consists of 898,154 episodes, covering 67,749 unique physicians and 3,584 unique hospitals. Data on hospital ownership of physician practices comes from the SK&A physician survey database. These data offer several advantages compared to other common measures of alignment, such as a hospital's self-reported classification within the American Hospital Association (AHA) annual surveys (Cuellar &

[2] In our context, practice ownership prior to being vertically integrated could be a sole proprietorship or a partnership share in a given practice or (horizontally integrated) physician group.

Gertler, 2006; Ciliberto & Dranove, 2006; Baker *et al.*, 2014). We supplement these data with information on hospital characteristics and county demographics from a variety of sources, including the AHA annual surveys and the American Community Survey (ACS).

For each episode, our outcomes include total spending, physician work relative value units (RVUs), count of services, count of unique visits, and count of claims.[3] We discuss our motivation for these outcomes and our construction of the variables in more detail in Section 3. Our preferred regression specifications include physician-hospital fixed effects as well as a rich set of patient, hospital, and market characteristics. The key variable of interest in all cases is an indicator for whether the operating physician is part of a practice owned by the hospital system.

Our empirical strategy exploits changes in episodes for the same physician-hospital pairs over time, with treatment effects identified from variation in physician-hospital pairs before and after integration. Due to endogeneity concerns surrounding integration, we further propose an instrumental variables (IV) strategy using a 2010 Medicare payment shock as our instrument. Dranove & Ody (2019) examine this payment shock in detail, showing that the shock had a significant and meaningful effect on hospital acquisitions of physician practices. The purpose of the payment shock, as discussed in more detail in Section 4, was to update Medicare's physician payment formulas using new survey information. The update differentially affected services provided in an office setting versus a facility setting, thereby increasing the incentive for hospitals to acquire certain physician practices. We construct as our instrument the total additional revenue gained per physician practice due to the payment updates, if the visits were billed in a facility setting compared to a physician's office.[4]

From our IV analysis and preferred specifications, we estimate an increase in episode-level spending following vertical integration, alongside a large reduction in the count of services and claims per episode.[5] Specifically, our point estimates suggest a statistically significant 4-5% increase in spending per episode among vertically integrated physician-hospital pairs, with over 16% fewer services per episode and 20% fewer claims. There is suggestive evidence of a potential increase in the intensity of services (i.e., physician work RVUs) provided—though these results are sensitive to the econometric specification.

We then decompose each episode into different places of service and different service types. For

[3]We focus on the relationship between vertical integration and spending/utilization; however, effects on quality are clearly relevant when interpreting any effects on spending. We therefore present results for quality in the supplemental appendix. In general, we find little evidence of any meaningful change in quality following vertical integration, as measured by mortality, readmission, and complications. These findings are consistent with those of Carlin *et al.* (2015) and Koch *et al.* (2021), among others.

[4]We also consider a version of this instrument constructed relative to other practices with admitting privileges for the same hospitals, therefore introducing variation both at the physician and hospital level. Results from this alternative instrument are presented in the supplemental appendix and are qualitatively similar to our main estimates.

[5]We focus much of our discussion on the IV estimates, with OLS estimates presented in the supplemental appendix.

place of service, we consider inpatient, outpatient, SNF, home health, and office settings. We find large increases in outpatient utilization and spending, consistent with the movement into outpatient-based visits and the subsequent site-of-care payment differentials between outpatient versus office-based care (Koch *et al.*, 2017). We also find that the increase in outpatient utilization derives almost entirely from the substitution of office-based care into outpatient facilities. For service types, we consider labs, imaging, and evaluation and management (E&M) visits. Here, we estimate a reduction in E&M claims and service counts, alongside an increase in E&M spending and RVUs. This suggests an increase in intensity of services but a decrease in overall number of services provided. We find no evidence of meaningful effects on imaging or labs. Finally, we also consider episode spending among other integrated versus non-integrated providers, where we find a large and significant increase in spending and quantity of care to other integrated providers, offset by a reduction in spending and quantity of care to non-integrated providers. These results suggest that hospitals are able to keep more care within the system when owning the focal physician's practice, which reveals an indirect channel for financial benefits from a given practice acquisition.

Given the potential for integration to disincentivize effort, we conclude our analysis by examining the effects of vertical integration on total physician activity, measured as yearly physician-level spending, work RVUs, services, visits, and claims. This analysis is based on 100% of Medicare claims data for each physician, rather than a 20% sample of Medicare FFS beneficiaries. We find that integrated physicians significantly increase spending and quantity of services provided after integration, with a particularly pronounced increase in services at the inpatient and outpatient level alongside a large reduction in office-based services. We further consider spending and utilization specifically among the top 10 HCPCS codes, where we find large reductions in services at the lowest-intensity codes and similarly large increases for the higher-intensity codes. For example, consider codes 99203 (new patient office visit, 30-44 minutes) and 99204 (new patient office visit, 45-59 minutes). We find that physicians reduce spending in code 99203 by 54% following integration and increase spending by 82% in code 99204. These results are consistent with a large effect of integration on physicians' coding intensity following hospital acquisition.

Our findings contribute to two related literatures. Our first contribution is to the broader literature on physician agency. In documenting physician agency problems, authors typically examine changes in physician treatment choices due to relative differences in financial incentives across services (e.g., Afendulis & Kessler (2007), Clemens & Gottlieb (2014), Gruber & Owings (1996), and Iizuka (2012), among others). The presence of physician agency problems is also implicit in studies of unexplained geographic variation in health care utilization (e.g., Finkelstein *et al.* (2016) and Molitor (2018), among many others). Our analysis identifies physician-to-physician referrals as another important dimension of physician agency, whereby hospitals appear to use vertical integration to limit leakage to non-integrated providers. In this way, our work highlights the physician's relationship with the hospital as a potential mediating factor in understanding effects of physician agency on patient care, which also aligns with several recent studies focused on diagnostic testing quantities and referral choices when physicians are hospital-owned (Chernew *et al.*, 2021; Whaley *et al.*, 2021; Young *et al.*, 2021; Richards *et al.*, 2022; Whaley & Zhao, 2024).

In addition, our work directly connects to the literature on the effects of vertical integration on various outcomes, such as physician practice prices (Capps *et al.*, 2018), hospital prices (Baker *et al.*, 2014; Lin *et al.*, 2021), changes in location of professional services (Koch *et al.*, 2017; Richards *et al.*, 2022; Whaley *et al.*, 2021), changes to physician referrals (Carlin *et al.*, 2016; Baker *et al.*, 2016a; Walden, 2016), total spending (Neprash *et al.*, 2015; Baker *et al.*, 2016a; Capps *et al.*, 2018), quality of care (Koch *et al.*, 2021; Carlin *et al.*, 2015), and physician effort (Post *et al.*, 2023). While it is clear from this literature that vertical integration affects physician and hospital behaviors in various ways, some of these changes may offset each other. For example, higher-priced services may not translate to higher spending if integration also affects the quantities of care consumed. Likewise, more within-organization referrals may blunt competition or forgo lower cost options, but it may also reduce duplication of services and improvement the care of the patient overall. Analyses of a given care attribute (e.g., service price) or care decision (e.g., site-of-care delivery) alone cannot adequately speak to these broader considerations, which leaves the overall effects of vertical integration on spending and utilization unclear.

Our paper extends this literature in several important ways. First, our IV approach attempts to address endogeneity of vertical integration. Second, the scope of our analysis is broad and speaks to the overall effects of integration, accounting for dimensions by which spending may increase while also considering potentially offsetting behaviors such as a reduction in referrals to other physicians, labs, imaging, etc., or an overall reduction in physician effort. Third, we focus on episodes for elective surgical care. Such elective procedures are highly common to Medicare beneficiaries and are known to be vitally important for hospitals' revenues and profit margins. Moreover, elective surgeries have the benefit of lending themselves to clinically and analytically well-defined episodes or "bundles" of care. Our construction of elective surgical care episodes, comprehensive assessment of quantities of care and spending within episodes, and consideration of potential endogeneity of vertical integration represent novel and important additions to the body of evidence around vertical consolidation of providers in U.S. health care.

Finally, our clinical setting also provides an ideal context to explore disincentives to work after transitioning from self-employment to a hospital employee—a margin that has to-date only been examined in the context of primary care physicians (Post *et al.*, 2023). Surgeons are, by definition, proceduralists, with the bulk of their revenue generation directly connected to the provision of surgical interventions. We are also able to carefully quantify within-episode ancillary care provided inside versus outside the physician's new parent organization. In other words, we not only demonstrate if the physician's own billable effort changes following integration, but we also assess if they alter the intensity and source of ancillary care under their guidance and how this influences the overall cost and quality of care.

2 Motivation and Conceptual Framework

We motivate our empirical analysis with a simple model of physician behavior (Ellis & McGuire, 1996; Finkelstein & McGarry, 2006). We assume physician j and hospital k initiate an episode of care for patient i, the goal of which is to maximize the perceived utility of patient i as well as the profits of the physician (or the physician's practice) or the hospital. The total amount of care delivered in this episode is denoted y_{ijk}.[6] Note that the initiating physician-hospital pair is *not* assumed to *directly* provide all care in the episode—they need only maintain some influence on treatment patterns throughout the episode.

Given the inherent differences in revenue generation for a physician-owned versus hospital-owned practice, we split this optimization problem between physicians that are vertically integrated with a hospital (VI) and those that are non-integrated (NI).[7] Denote profits to a non-integrated physician by $\pi_{j,NI} = R_j\left(y_{ijk}\right) - c_{j,NI}\left(y_{ijk}\right)$, where R_j captures the net revenue to the physician (reimbursement net direct costs of patient care) and $c_{j,NI}$ denotes other indirect costs not reimbursed by insurers. Denote profits to the hospital by $\pi_k = R_k\left(y_{ijk}\right) - c_k\left(y_{ijk}\right)$ and perceived patient utility by $\tilde{u}(y_{ijk})$. Omitting subscripts on the revenue and cost functions, we assume that $R'\left(y_{ijk}\right) > 0$ and $R''\left(y_{ijk}\right) \leq 0$; $c'\left(y_{ijk}\right) > 0$ and $c''\left(y_{ijk}\right) > 0$; and $u'(y_{ijk}) > 0$ and $u''(y_{ijk}) \leq 0$. Assuming that the physician's objective is additively separable in perceived patient utility and profits, the non-integrated physician's objective function is

$$y_{ijk}^{NI} = \arg\max_{y} \left\{\theta_u \tilde{u}\left(y; \Gamma_k, \Gamma_j, \kappa_i\right) + \theta_\pi^j \pi_{j,NI}\left(y; \Gamma_k, \Gamma_j, \kappa_i\right)\right\},$$

[6]To simplify notation, we let the subscript j denote physician j within a given practice. Our empirical analysis ultimately restricts the sample to physicians that operate in a single practice, so that we can uniquely assign practice characteristics (including ownership by a hospital system) to the physician.

[7]The type of integration in this paper, that of a hospital purchasing a physician practice, differs from some recent studies in the literature. Starc & Town (2020), for example, examines the effects of integration in the design of Medicare Advantage benefits, while Cuesta *et al.* (2019) considers the effects of vertical integration between hospitals and insurers.

where Γ_k, Γ_j, and κ_i reflect hospital, physician, and patient characteristics, respectively, and θ_u and θ_π^j capture different weights that the physician places on perceived patient utility and own-profits. The solution to the non-integrated physician's optimization problem therefore satisfies the following,

$$\theta_u \tilde{u}'\left(y_{ijk}^{NI}\right) = \theta_\pi^j \left(c'_{j,NI}(y_{ijk}^{NI}) - R'_j(y_{ijk}^{NI})\right). \tag{1}$$

Similarly, denote the profits to a vertically integrated physician by $\pi_{j,VI} = \bar{R} - c_{j,VI}\left(y_{ijk}\right)$, where $\bar{R}$ denotes a fixed salary received from the acquiring hospital. The vertically integrated physician's objective function is

$$y_{ijk}^{VI} = \arg\max_y \left\{\theta_u \tilde{u}\left(y; \Gamma_k, \Gamma_j, \kappa_i\right) + \theta_\pi^j \pi_{j,VI}\left(y; \Gamma_k, \Gamma_j, \kappa_i\right) + \theta_\pi^k \pi_k\left(y; \Gamma_k, \Gamma_j, \kappa_i\right)\right\},$$

reflecting the fact that a vertically integrated physician may incorporate hospital profits into their objective function. The weight assigned to the hospital's profit function in the physician's optimization problem is captured by θ_π^k. The optimal amount of care (from the physician's perspective) for an integrated physician is then reflected by

$$\theta_u \tilde{u}'\left(y_{ijk}^{VI}\right) = \theta_\pi^j c'_{j,VI}(y_{ijk}^{VI}) + \theta_\pi^k \left(c'_k(y_{ijk}^{VI}) - R'_k(y_{ijk}^{VI})\right). \tag{2}$$

Comparing Equations 1 and 2, and assuming that perceived patient preferences remain unchanged, we see that the optimal amount of care for a vertically integrated versus non-integrated physician depends largely on two factors. First, as an employee, an integrated physician's marginal revenue for own-profits drops to zero. All else equal, this would tend to reduce the amount of care in an episode. This is a classic agency mechanism in which salaried arrangements disincentivize effort relative to being self-employed. We consider these effects in Section 7.

Second, for a vertically integrated physician, the hospital's profit function is now part of their optimization problem. The extent to which this affects treatment decisions depends on the relative size of θ_π^k versus θ_π^j. If θ_π^k is sufficiently large, then we would expect an adjustment to treatment patterns that is more financially favorable to hospitals.[8] The introduction of the hospital's profit function into the physician's optimization problem therefore introduces the potential for hospitals to influence physician behaviors toward the hospital's financial gain.

[8] It is reasonable to assume that the physician's marginal costs do not meaningfully change after integration with a hospital; however, integration may reduce practice costs by lowering the administrative burden of seeing patients, or integration may increase the costs of communicating with non-integrated physicians (e.g., due to barriers in sharing information via electronic medical records). Such costs are notoriously difficult to measure, and we have no such measures available in our data.

There are two primary ways in which we envision a hospital influencing physician treatment decisions in our setting.[9] First, hospitals may influence where care is delivered. For example, a physician can choose to operate in the acquiring hospital, k, as opposed to some other hospital for which the physician also has admitting privileges. Vertical integration is then a mechanism by which the hospital increases the probability of the physician operating in their hospital relative to that of a competitor hospital (Baker *et al.*, 2016a). Moreover, integrated physicians may bill for the same visit as an outpatient service instead of a standard office visit, taking advantage of the fee differentials (a motivation for increased physician-hospital integration) even though the nature and physical location of the visit itself is identical. Koch *et al.* (2017) find strong empirical evidence of such behavior. This dimension of hospital influence will tend to increase total spending but may not affect aggregate quantity of care within an episode.

Second, hospital influence may determine which providers a patient visits throughout the episode. Specifically, hospitals may prefer that patients only visit other physicians within the same hospital system, otherwise restricting visits to non-integrated physicians. Imposing these forms of restrictions may confer additional bargaining power to the hospital (Gowrisankaran *et al.*, 2015; Ho & Lee, 2017) and lead to higher physician and hospital prices for commercially insured population (Capps *et al.*, 2018; Baker *et al.*, 2014; Lin *et al.*, 2021). Of particular interest to our setting, this dimension of hospital influence will tend to increase the amount of care to other integrated physicians at the expense of non-integrated physicians. Whether the total amount of care and spending will decrease or increase remains an empirical question.

Ultimately, this discussion suggests that vertical integration creates both upward and downward pressure on the total amount of care, with potentially offsetting effects on spending. Downward pressure derives from the loss of marginal revenue from the physician's profit function, and potentially from a reduction in care delivered by other, non-integrated physicians, while upward pressure derives from the standard financial incentive to provide more care, all else equal. Fully examining the effects of vertical integration on the amount of care therefore requires a more comprehensive measure of treatment, as reflected in our episode-based outcomes and our aggregate analysis of yearly physician spending and treatment decisions.

Empirically, we assume $\tilde{u}$, π_j, and π_k are additively separable in i and (j,k,t). A reduced-form analog to Equations 1 and 2 then follows:

$$y_{ijkt} = x_{it}\beta_x + w_{jkt}\beta_w + \text{VI}_{jkt}\delta + \gamma_{jk} + \lambda_t + \epsilon_{ijkt}, \tag{3}$$

[9] Although not part of our analysis, researchers also posit that vertical integration may facilitate some form of product bundling wherein hospitals group many services together (Madison, 2004; Afendulis & Kessler, 2007).

where x_{it} denotes a vector of patient characteristics, some of which may be time-invariant; w_{jkt} denotes observed and potentially time-varying hospital and county characteristics; VI_{jkt} denotes an indicator for whether hospital k owns the practice of physician j at time t; γ_{jk} denotes time-invariant physician-hospital fixed effects; λ_t denotes time fixed effects; and ϵ_{ijkt} is an error term. The key variable of interest is the indicator for whether the physician practice is owned by the hospital, VI_{jkt}. We consider this overall effect in Section 5. We then attempt to decompose this overall effect into the two areas discussed above. First, in Section 6.1, we examine changes due to reallocation of care across different places and types of services within an episode. Second, in Section 6.2, we consider effects of vertical integration on visits to other integrated versus non-integrated providers within the episode. Finally, in Section 7, we extend our analysis to the physician-level and examine total physician spending, work RVUs, patients, and claims per year.

3 Data

3.1 Dataset Construction

Our analysis aims to quantify the overall effects of vertical integration by examining spending and utilization over an extended, well-defined period rather than a single visit. We refer to this extended period as an "episode of care," adopting the language from CMS regarding bundled payments. We define an episode as all care observed during a 90-day period after a planned inpatient stay as well as all professional services incurred 30 days prior. This definition and construction of an episode follows recent guidance from CMS in calculating bundled payments for joint replacement (Mechanic, 2015). Ellimoottil *et al.* (2017) also find that this broad construction of an episode highly correlates with a more clinically narrow definition, such as the episodes constructed in the Hospital Compare data and the RAND health insurance experiment (Aron-Dine *et al.*, 2013).

We define a planned admission as an elective admission type that is initiated by a physician or clinic, as captured in the admission source variable in the Medicare claims data. This excludes, for example, transfers from other hospitals or inpatient stays initiated through the emergency department, urgent care center, or trauma center. Our analysis is based on Parts A and B claims for a 20% sample of Medicare FFS beneficiaries from 2010 through 2015. We also employ data from 2009 in constructing our instrument, but we focus on the 2010-2015 period for our analysis as those are the years in which our instrument offers identifying variation.

Planned procedures are of interest as they facilitate clinically and analytically well-defined episodes of care. This is not typically the case for many genres of physician services, including primary care;

however, in the context of planned inpatient surgeries, examining episodes of care is both feasible and advantageous as it allows a comprehensive assessment of all care delivery within the demarcated episode—knowing that the focal surgeon and hospital exercise considerable influence on the resulting quantities of care, where care takes place, and who delivers these ancillary services. One potential concern is that integrated physicians may reallocate elective procedures across inpatient versus outpatient settings. However, this is unlikely to have a large effect in our setting because the overwhelming majority of procedures in our data are major joint replacements, which are performed exclusively in an inpatient setting during our time period (Richards *et al.*, 2021). Morevoer, when we limit our sample only to such major joint replacements, we estimate similar overall findings. Those results are included as part of our specification curves discussed in Section 5.

We construct a dataset of all 90-day episodes from 2010 through 2015 among Medicare FFS beneficiaries aged 65 and above, where each episode is initiated by a planned and elective inpatient stay. All episodes in our final data are non-overlapping, so that any elective inpatient stay observed within an existing episode is treated as an inpatient stay in that episode rather than as initiating a new episode. The operating physician associated with the initial inpatient stay is assigned as the physician to that episode. Similarly, the admitting hospital for the initial inpatient stay is assigned as the hospital for the episode. Our final dataset consists of just under 900,000 episodes, with 85,500 unique physician/hospital pairs based 3,584 unique hospital NPIs and 67,749 unique physician NPIs. Details of the construction of our data are discussed in the supplemental appendix.

We incorporate additional hospital-level data from the provider of service (POS) files and the AHA annual surveys, which we merge to the episode data using the Medicare provider number. These data include the number of staffed hospital beds and indicators for hospital teaching status, membership in a larger hospital system, and for-profit/not-for-profit ownership. We further incorporate hospital financial information and data on total discharges from the Healthcare Cost Report Information System (HCRIS), again merged based on the Medicare provider number. Finally, we incorporate local demographic and other county-level variables from the American Community Survey (ACS), merged based on county FIPS codes observed in the AHA data.

Our data on hospital ownership of physician practices comes from SK&A, a commercial research firm that regularly surveys the ambulatory physician practice landscape. The SK&A database provides detailed information regarding practice ownership affiliations (including the health system name for those vertically integrated), practice specialty, practice size, and practice location.[10] The SK&A data also includes each physician's NPI, which we use to merge to the claims data. As described in

[10]Since SK&A focuses on the office-based physician practice landscape, our analysis does not consider hospitalists or other forms of hospital-based physician employment.

more detail in the supplemental appendix, the SK&A data provides information on integration status in at least one year for over 90% of the physicians in our data. Our high match rate is also generally consistent with the findings in Maurer *et al.* (2021) and Baker *et al.* (2016b), who specifically examine coverage of physician practices in the SK&A data.

The SK&A data provide the most comprehensive measure of physician-hospital integration for which we are aware, particularly for the scope and scale of data in our analysis. These data are also widely used in the literature on physician-hospital integration. That said, the SK&A data offer an imperfect measure of integration and may fail to report physicians as integrated. Such measurement issues appear most pronounced in years prior to our analysis (Capps *et al.*, 2018), and our IV strategy helps to alleviate bias due to measurement error over our time frame. Remaining bias due to measurement error will tend to attenuate our estimates.

3.2 Dependent Variables

Our unit of observation is a 90-day episode beginning with a planned and elective inpatient stay, and our main outcomes are total spending, physician work relative value units (RVUs), total service counts, number of unique visits, and number of claims. Our outcomes are constructed from all Parts A and B claims except for durable medical equipment (DME) and hospice care, capturing the overwhelming majority of all health care utilization within each episode and over 75% of annual spending per patient. Our measure of spending also captures both Medicare spending as well as any patient out-of-pocket spending (Curto *et al.*, 2019; Zhang *et al.*, 2021).

Our intention with using count of claims, visits, and service counts as outcomes is to construct a measure of utilization that is unaffected by Medicare payment policies or by potential upcoding, as is potentially the case with spending and RVUs. Baker *et al.* (2016b) similarly employ claim counts as a measure of quantity, among other related measures. Cabral & Mahoney (2019) also use "Part B Events" as an outcome measure in some of their analyses, which they construct as the count of line item claims.[11]

We also consider several measures of quality, including 90-day mortality, 90-day readmissions, and other complications. We measure complications based on the incidence of sepsis and surgical site infections (SSI) within the 90-day episode. All quality measures are therefore constructed based on

[11] Danagoulian & Wilk (2022) also use claim counts as a measure of utilization in their study of dental services, and Einav *et al.* (2018) use Part D claim counts as a measure of utilization in their study of prescription drugs. Further, CMS provides claim counts as a measure of utilization in some of their analytic files. For example, the Medicare-Medicaid Linked Enrollee Analytic Data includes a variable which CMS describes as "Medicare Use" (https://resdac.org/cms-data/files/mmleads-3/data-documentation) and which is calculated as "the count of all claims from the IP, SNF, HHA, Hospice, HOP, Carrier, and DME claims as well as the count of PDEs for the beneficiary for the year"

the same 90-day time frame as our spending measures. We define "any" complication as whether the patient is diagnosed with sepsis or SSI over the episode. Lists of ICD-9 diagnosis codes used to identify sepsis and SSI are included in the supplemental appendix. Since quality is of secondary interest in this analysis, we present our results on vertical integration and quality in the supplemental appendix. Across all specifications and estimators, we find no evidence that vertical integration meaningfully improves quality, consistent with previous findings such as Koch *et al.* (2021) in a related setting.

3.3 Independent Variables

Our primary independent variable of interest is an indicator for whether physician practice j is owned by hospital k (or the system to which hospital k is a member), $\mathbf{VI}_{jkt}$ in Equation 3. Our "treatment" is therefore defined at the physician-hospital level, with the operating physician and admitting hospital serving as the treated pair, consistent with the expositional framework in Section 2. This is not to suggest that the operating physician or admitting hospital has full control over all episode payments, but that they can have a large influence on treatment patterns before and after discharge. Intuitively, we consider vertical integration as one way in which hospitals can gain further control over pre- and post-discharge treatment patterns, and we assume that any such control is exercised in concert with the operating physician.

In our full specification, we also include in w_{jkt} of Equation 3 the following observables: 1) hospital characteristics, including the number of full-time equivalent (FTE) nurses, the number of FTE other medical staff, and indicators for whether the hospital is part of a larger system, for-profit versus not-for-profit ownership, and designation as a major teaching hospital;[12] and 2) county characteristics, including a set of variables that capture the county's distribution of age, income, gender, education, and race, as well as indicators for whether the county hospital market is a monopoly, duopoly, or triopoly.[13]

Since the same patient will not (on average) have several episodes for a given physician-hospital pair, we do not include patient fixed effects. We instead include in x_{it} a set of variables intended to capture the total health care utilization for patient i in years prior to time t. Specifically, we sum all claims and Medicare payments for each patient in all years before t, calculate the quartiles for each of these two variables, and form six indicator variables for whether the patient falls in the 2nd, 3rd, or 4th quartile of each variable.[14] We also include in x_{it} a dummy variable for the patient's race, sex, and

[12]The AHA survey data includes measures of physician and resident FTEs; however, we exclude such characteristics from our set of hospital-level controls since the acquisition of a physician practice will tend to also affect the number of physician or resident FTEs at the hospital.

[13]Since our specification also includes physician-hospital fixed effects, our results are largely insensitive to the inclusion or exclusion of the hospital and county-level covariates, w_{jkt}.

[14]In calculating total Medicare payments or claims, we make no restrictions on the type of procedures and include all

set of dummy variables for the DRG code, all based on the initiating inpatient stay for each episode.

3.4 Descriptive Statistics

Descriptive statistics for the episode-level data are provided in Table 1, as well as histogram of the 10 most frequently occurring DRGs in Figure 1. Consistent with national trends in inpatient care, we see a reduction in the number of episodes per year from nearly 184,000 in 2010 down to 135,000 in 2014.[15] We see also from Table 1 that an average 90-day episode incurs around $30,600 in Medicare payments, 23 unique dates (or "visits"), 87 work RVUs, 93 services, and 65 separate claims. We also present summary statistics for our selected quality measures. On average, mortality rates per episode are 3.9%, with readmission rates of 18% and complication rates (defined as "any" complication) of 5.9%. Finally, Table 1 shows that nearly 40% of episodes are initiated by an integrated physician-hospital pair in 2015 compared to 12% in 2010.

Tables 2–3 present descriptive statistics for individual physicians and hospitals, respectively. From Table 2, our final data consist of around 4.5 episodes per physician per year.[16] Also from Table 2, we see that around 12% of physicians in our data were integrated with a hospital or hospital system in 2010 compared to 42% in 2015. Recall that physicians can operate at multiple hospitals within the same system that owns their practice. Physicians may also (albeit infrequently) operate at hospitals outside of the system that owns their practice, such that the percentage of episodes initiated by an integrated physician-hospital pair in Table 1 should be slightly lower than the percentage of integrated physicians in Table 2.

Table 3 describes the average hospital in our data. From Table 3, there are 55 episodes per year in a given hospital,[17] and the initiating hospitals have an average of 211 staffed beds. Around 17% of hospitals in our data are designated as for-profit, which is lower than overall rates in the AHA data, and the percentage of hospitals reporting membership in a larger hospital system increased from 60% in 2010 to 69% in 2015. Our analytic sample therefore skews more toward larger, not-for-profit systems. Finally, the percentage of hospitals that are identified as owning at least one physician practice (or hospitals affiliated with a larger system that owns a practice) almost doubled from 43%

observed claims for each patient. This reflects substantially more observations per patient because the observations are not restricted to be planned and elective procedures.

[15]Note that this decrease in inpatient care is not driven by shifting to outpatient care since most of the procedures captured in our analysis could not be done in an outpatient setting. We restrict our 2015 data to January-September in order to ensure that we observe all claims for 90 days after the inpatient stay.

[16]In our specification curves in Figure 5, we include estimates when limiting the sample to physician-hospital pairs with more episodes, with little change in the results.

[17]Adjusting for our 20% sample, our data reflect around 275 episodes per hospital per year. This count of episodes is broadly consistent with other studies in the literature. For example, Dummit *et al.* (2016) report around 200 "lower extremity joint replacement admissions" per year in their study of the hospital bundled payment program. We include a broader set of conditions but with the restriction to planned and elective inpatient stays as per the admission source codes.

in 2010 to 71% in 2015.

4 Estimation Strategy

Our primary independent variable of interest is an indicator for whether physician j's practice is owned by hospital k or the larger system to which hospital k is a member. To estimate this effect, we first present the results of a difference-in-differences estimation based on the estimator proposed in Callaway & Sant'Anna (2021).[18] Here, we define the treated group as any physician-hospital pair that becomes vertically integrated in a given year, and our control group consists of all physician-hospital pairs that are not vertically integrated at any point over our time period. For this analysis, we exclude all control variables in order to focus solely on the change in episode-level outcomes before/after integration among physician-hospital pairs.

The results are presented in Figure 2, where the top panel presents event study results for log payments and log RVUs, the middle panel presents results for log service counts and log events, and the bottom panel presents results for the log number of claims. Figure 2 suggests a negative relationship between integration and claims as well as integration and service counts, with a potential increase in Medicare payments. These results point toward offsetting effects of hospital ownership on billable activity and site of service differential payments (i.e., care quantities versus prices). That said, the two-sided matching process inherent in the hospital's acquisition of a physician practice introduces some ambiguity in the interpretation of our findings. Specifically, hospitals' acquisition targeting strategy and/or physicians' underlying desires to become employed could introduce important confounding for these key outcomes of interest.

To mitigate such concerns, we enhance our empirical approach by adopting an instrumental variables (IV) research design that exploits a plausibly exogenous update to the physician fee schedule in 2010 as an instrument. Our identification strategy is therefore akin to a shift-share IV design, where the shift (e.g., the update to the physician fee schedule) acts as our exogenous variation (Goldsmith-Pinkham *et al.*, 2020). Dranove & Ody (2019) study this price shock in detail and present strong empirical evidence that the payment change affected physician-hospital vertical integration. Since our analysis focuses on a different set of physicians in a different empirical context, we explain and revisit some of their analysis here before presenting the IV results.

[18] We also present ordinary least squares (OLS) estimates of Equation 3 in the supplemental appendix.

4.1 Institutional Background

To better understand the update to the physician fee schedule, recall that CMS pays physicians an administratively set fee based on the relative RVUs of each service. There are three RVUs for any given procedure or service: 1) a work RVU, which is an estimate of the cost of the physician's work for each service; 2) a malpractice RVU, which is an estimate of the malpractice costs for each service; and 3) a practice expense RVU, which is an estimate of the practice expenses for each service and may differ depending on the location of the service (e.g., a physician's office versus outpatient facility). The practice expense RVU is further split into direct and indirect expenses, where the indirect expenses are calculated as some percentage of direct expenses. CMS then takes the sum of these three RVUs and multiplies by an RVU-to-dollar conversion factor in order to find the final dollar figure for each service.

Prior to 2010, CMS relied in-part on the American Medical Association's (AMA's) Socioeconomic Monitoring System survey to calculate the indirect/direct cost ratios in the practice expense RVUs. This information was eventually perceived as outdated, and in 2007-2008, CMS deployed a new survey to update their indirect/direct cost estimates. This new survey was the Physician Practice Information Survey (PPIS). As highlighted in Dranove & Ody (2019), the PPIS acts as a shock to the payment differential between services provided in an office versus facility setting. Acquiring physician practices, and thus exploiting the payment differentials between office and facility settings, became more or less attractive to hospitals due to the PPIS. Note that the PPIS price shock was phased in over a four-year period, with 1/4th of the full price differential introduced in 2010, 1/2 of the differential in 2011, 3/4ths of the differential in 2012, and the full payment differential in 2013. In our following analysis, we allow for the price shock to have differential effects over the years.

4.2 Calculation of PPIS Price Changes

Following Dranove & Ody (2019), we measure the price changes due to PPIS in two steps. First, we construct the price change relative to the baseline 2009 price, separately for facility and non-facility (e.g., office-based) payments and separately for each HCPCS code, c. We denote these price changes by $\Delta p^c_{f,t} = p^c_{f,t} - p^c_{f,2009}$ for facility payments and $\Delta p^c_{nf,t} = p^c_{nf,t} - p^c_{nf,2009}$ for non-facility payments. Second, we construct the relative price differential, $\Delta p^c_{r,t} = \Delta p^c_{f,t} - \Delta p^c_{nf,t}$, as the difference in price changes between facility and non-facility payments. This reflects the additional distortion in facility versus non-facility payments introduced by the PPIS.

We then aggregate $\Delta p^c_{r,t}$ up to the physician level based on the physician's count of office-based claims for HCPCS code c. We use 2008 claims for physician j in order to avoid additional endogeneity of claim counts due to the price changes, denoted by $q_{j(c),2008}$, and we weight this measure by 2008 non-facility prices. Finally, we normalize this total revenue change by the non-facility revenue in 2008. The resulting physician-level measure is:

$$\Delta \text{Revenue}_{j,t} = \frac{\sum_c \Delta p^c_{r,t} \times q_{j(c),2008} \times p^c_{nf,2008}}{\sum_c q_{j(c),2008} \times p^c_{nf,2008}}. \tag{4}$$

In constructing the quantities, $q_{j(c)}$, we exclude all HCPCS codes that appear to be "exclusive" to a non-facility setting, which we define as occurring over 90% of the time in a non-facility setting versus a facility setting. For consistency with Dranove & Ody (2019), we also calculate an analogous measure of the relative revenue increase due to a different change to the physician fee schedule phased in from 2007 to 2010. We refer to the revenue change from the 2007 price shock as $\Delta \text{Revenue}^{2007}_{j,t}$ and from the 2010 price shock as $\Delta \text{Revenue}^{2010}_{j,t}$, noting that the revenue change from the 2007 price shock is calculated relative to a 2006 baseline price while the 2010 price shock is calculated relative to a 2009 baseline price.

4.3 Evaluating the PPIS as an Instrument

Since hospitals ultimately acquire physician practices rather than individual physicians, we construct our instrument as the total $\Delta \text{Revenue}^{2010}_{j,t}$ at the practice level, based on physician tax IDs in 2009 (the year prior to our main analysis). Our resulting instrument relies on two main sources of variation. First, variation may come from codes and places of service for which a physician bills. Two physicians with similar patient types may still vary significantly in their practice styles and thus appear more or less affected by the price shock. Second, physicians may be in two very different practices, particularly with regard to the presence of primary care physicians for whom the opportunity to exploit site-of-care payment differentials is largest. In such cases, physicians in practices with a larger primary care presence will tend to have higher instrument values. Empirically, Figure 3 presents the practice-level $\Delta \text{Revenue}^{2010}_{j,t}$ over time, separately for practices that are vertically integrated at some point over our panel versus physicians that are never integrated. We see from the figure a clear diversion in the relative revenue gained from PPIS among vertically integrated and non-integrated physicians, which suggests that hospitals focused their acquisitions on physician practices with higher potential for revenue gains due to site-of-care payment differentials.

To examine this incentive more formally, we again follow Dranove & Ody (2019) and estimate a linear probability model of vertical integration as a function of $\Delta \text{Revenue}^{2010}_{j,t}$ and $\Delta \text{Revenue}^{2007}_{j,t}$, interacted with year dummies. Specifically, we estimate the following specification:

$$VI_{jt} = \alpha + \gamma_t + \sum_{t=2010}^{2015} \beta_t^{2007} 1(\text{year}_t) \Delta\text{Revenue}_{j,t}^{2007} + \sum_{t=2010}^{2015} \beta_t^{2010} 1(\text{year}_t) \Delta\text{Revenue}_{j,t}^{2010} + \varepsilon_{jt},$$

where VI_{jt} is an indicator for whether physician j is integrated with any hospital at time t; γ_t denotes a year fixed effect; $1(year_t)$ denotes an indicator for the observation being in year t; and $\Delta\text{Revenue}_{j,t}^{2007}$ and $\Delta\text{Revenue}_{j,t}^{2010}$ are defined in Equation (4). In Figure 4, we present the point estimates and 95% confidence intervals for the coefficients on $\Delta\text{Revenue}_{j,t}^{2010}$ and year interactions. The results show an economically large and statistically significant increase in the probability of integration from the PPIS price shock.[19]

While the results in Figures 3 and 4 show that the PPIS price shock is predictive of integration, the strength of our identification strategy ultimately relies on the exclusion restriction that the site-of-care payment differential due to the PPIS price shock only affects our outcomes through integration and not some other avenue. In our context, this assumption essentially holds by definition because a hospital that does not integrate with its physicians cannot exploit the site-of-care payment differentials as constructed in our analysis. In other words, there is little reason to expect the instrument to change a physician's or hospital's incentives (and thus change episode-level outcomes) unless that hospital exploits the site-of-care payment differential by acquiring the physician practice.

5 Vertical Integration and Episode Spending and Utilization

We employ the practice-level PPIS price shock as an instrument for observed integration. The first-stage results, discussed in more detail in the supplemental appendix, show a positive relationship between the price shock and vertical integration, with a first-stage F-statistic of over 300 on the price shock coefficient. We present the IV estimates in Table 4, with results for different outcomes presented along the rows and each column reflecting a different covariate specification.

[19]Our data cover the years 2009 through 2015, so all coefficients are relative to 2009, and the mean $\Delta\text{Revenue}_{j,t}^{2010}$ in this analysis is just over 15. The coefficient estimate, $\hat{\beta}_{2012}^{2010} = 0.00095$, therefore implies a 1.4 percentage point increase in the probability of integration in 2012 compared to 2009 from the PPIS price shock. Aggregating these point estimates from 2010-2012 yields an estimated increase of around 2 percentage points. Over this same time period, we observe an increase of roughly 20 percentage points in the share of physicians integrated with a hospital. Our estimates therefore suggest that the PPIS revenue differential can explain around 10% of the observed increase in physician-hospital integration among our sample of physicians.

5.1 Main Results

Column 1 presents results with separate physician and hospital fixed effects, in which case the identifying variation for our integration dummy derives from within-physician and within-hospital changes over time. Our specification in column 2 instead includes pairwise physician-hospital fixed effects, therefore narrowing the identifying variation into within-pair changes over time. This identification relies on variation in episodes among the same physician-hospital pairs over time, both before and after integration, which we observe for approximately 62% of all integrated pairs. Columns 3-5 again include physician-hospital fixed effects in addition to different sets of observable covariates. Our preferred specification is presented in column 4, which includes adjustments for patient, county, and hospital observables.

Across all specifications, we estimate a statistically significant and economically meaningful increase in episode spending of around 4-5%. We also estimate a large reduction of around 16% in service counts and a reduction of 20% in claims per episode following vertical integration. Results for RVUs suggest a potentially meaningful increase in work RVUs of 6-7%; however, these results are statistically insignificant in our preferred specifications, and our broader set of specifications presented in Figure 5 suggest that integration has at most a small increase on work RVUs per episode. Collectively, our IV results suggest an increase in episode spending alongside a large reduction in the number of services and claims per episode. This pattern of results is consistent with an increase in spending per claim (due in-part to a movement from office-based physician visits to outpatient facilities) which is offset by a reduction the total number of services and claims. We investigate this pattern in more detail in Section 6.1.

We also present a specification curve in Figure 5 that shows the results of several alternative specifications and samples. Changes in covariate specifications follow our main results in Table 4, where we consider first a baseline specification with physician-hospital fixed effects and patient characteristics, and we layer in additional controls for county-level, hospital-level, and ultimately measures of the quality of care for the episode.

Our specification charts also consider several alternative sample restrictions. Our concern is that, while we restrict the analysis to episodes initiated by a planned, elective inpatient stay, there remains a wide variety of different procedures and thus physician types in our final dataset. In our alternative samples, we consider restrictions on the number of episodes per physician-hospital pair, thereby focusing on relatively more "familiar" physician-hospital pairs (i.e., excluding physician-hospital pairs with very few interactions over time). We also consider explicit restrictions on the types of surgeries, where we focus only on major joint replacements (DRGs 469 and 470). The DRG restrictions are reflected in the specification curve with the "DRGs" label. Finally, as an additional form of risk adjustment, we restrict the sample to only patients that are discharged to home in the initial inpatient stay, as reflected by the label "Home" in the specification curve.

We estimate effects separately across all combinations of specifications and sample restrictions. In all cases, the highlighted dot denotes our preferred estimates from Table 4 (i.e., the full sample with patient, county, and hospital covariates). This figure offers some reassurance that the findings from our preferred specification are robust to a range of specification/sample restriction combinations.

We conclude this section by discussing two remaining confounding factors in our analysis.[20] First, patients may prefer vertically integrated physician-hospital pairs over non-integrated pairs for unobserved reasons that are correlated with health care utilization. We attempt to address this concern by employing a rich set of controls, including measures of the patient's entire history of Medicare claims and spending, DRG codes for the initiating inpatient say, and a set of physician-hospital fixed effects. Our results also persist when limiting our analysis only to patients undergoing major joint replacement without complications or comorbidities (DRG 470) or when limiting only to patients discharged to home. These samples of patients are relatively healthy. Limiting the analysis to such subsamples therefore helps to address concerns regarding integration and selection of patients.

Second, integration might affect where the procedure is performed. However, selection into inpatient versus outpatient surgery plays an inconsequential role in our setting. This is because we examine episodes initiated with a planned and elective inpatient stay, the overwhelming majority of which are joint replacements or reattachment of lower extremity without major complications. During our study period and for our population, major joint replacements are performed exclusively in an inpatient setting (Richards *et al.*, 2021). Our results are also unchanged when focusing only on patients undergoing major joint replacements (see Figure 5). It is therefore unlikely that our results are driven by integration leading to switching between inpatient and outpatient settings in our data.

5.2 Mechanical versus Behavioral Responses

While our theoretical model envisions episode-level outcomes as a reflection of physician treatment decisions, our outcomes are also affected purely by "mechanical" changes due either to Medicare payment policies or hospital billing practices. Mechanical changes that may effect outcomes within a given physician-hospital pair are primarily limited to two areas.

First, site-of-care payment differentials will tend to increase revenue for integrated physicians,

[20]Another concern is the potential violation of the stable unit treatment value assumption (SUTVA) due to integrated physicians operating in other hospitals for which they are not integrated. This is an infrequent occurrence, affecting less than 5% of physicians in our data; however, to better assess the sensitivity of our results to this concern, we re-estimated our main coefficients after excluding all such physicians, with results similar to those in Table 4.

who can now bill a regular office visit as part of an outpatient service. However, these effects are limited to outpatient versus office-based physician visits, and should do not affect other outcomes such as overall episode *quantity* of care, referrals to different physicians, or total count of patients at the physician level. Our findings for total quantity of care in Table 4, as well as our analysis in Sections 6, and 7, therefore serve to disentangle behavioral responses from mechanical changes due to site-of-care payment differentials.

Second, mechanical effects of integration may derive from changes in billing practices among integrated physicians, wherein what might have been multiple claims for the same visit or physician can be consolidated after integration.[21] However, such consolidation alone should not effect episode spending and would tend to be isolated within a type or location of service. Moreover, such a mechanical reduction would be isolated among the acquired physicians, but our findings regarding referral patterns in Section 6.2 demonstrate that the reduction in claims comes entirely from non-integrated physicians, suggesting our results are not fully explained by claims consolidation following integration.

6 Reallocation of Care within an Episode

As has been documented, physician-hospital integration will tend to encourage substitution of office visits with outpatient facilities, which tend to increase spending to the integrated hospitals and physicians; however, integration might also lead to a reallocation of treatment to the acquiring hospital or away from non-integrated providers, thus potentially changing total amount of care and spending in ways other than site-of-care payment differentials. We consider each of these potential changes in the following subsections.

6.1 Changes in Location and Type of Service

In order to examine within-episode changes in spending and types of care, we split our episodes into five locations: inpatient, outpatient, office, SNF, and home health. We also consider four types of services: overall professional services, evaluation and management (E&M), imaging, and labs. We identify location based on the place of service codes listed on the claim, and we similarly identify the type of service based on the BETOS codes listed on the carrier claims. Results are presented in Table 5, where for each outcome, we re-estimate Equation 3 using our IV strategy as explained in Section 4.

[21] As discussed in Koch *et al.* (2017), "for [an outpatient] visit involving a hospital-employed physician...it is possible that a single unified claim would be submitted." This suggests that integration may simply transfer a claim from one care setting to another or may consolidate claims into the outpatient files if the physician was already billing their services in an outpatient setting.

Each cell in Table 5 reflects a different IV regression result, with the category of outcome (spending, work RVUs, etc.) presented along the columns and the place or type of service delineated by the rows. All results are in their original units, rather than logs, so as to allow comparisons in magnitudes across different places or types of services.

Consistent with Koch *et al.* (2017), we estimate relatively large and statistically significant increases in outpatient spending and utilization following vertical integration, as well as a large reduction in the quantity of services provided in the office setting. These results are consistent with the substitution of office visits from traditional physician offices into outpatient facilities. Indeed, for work RVUs, visits, and claims, our estimated increases in outpatient care are almost fully offset by a reduction in office-based care. Our results also suggest a reduction in SNF and an increase in HHA; however, these results are imprecisely estimated, particularly for SNF, and could derive from a substitution of SNF with HHA or from a change in the specific SNF and HHA providers used for a given episode. We consider the potential effects of vertical integration on discharge decisions as an interesting area of future research.

Our results on type of service in the bottom panel of Table 5 are mixed. We estimate a relatively large overall reduction in claims for professional services and E&M services, but such a reduction in claims does not translate into a reduction in spending. Our results for E&M services in particular reveal an increase in spending and work RVUs but otherwise a decrease in quantity of services and claims. This suggests a movement from lower-intensity into higher-intensity E&M services, which is also consistent with our analysis of overall physician effort in Section 7. Finally, estimates for imaging and labs are imprecise and generally quite small, with the exception of unique dates with a laboratory claim where we estimate a small increase and claim counts for imaging where we estimate a small reduction.

We conclude from Table 5 that integration appears to increase outpatient services and spending, reduce office-based services, and may also reduce the quantity of total professional services within an episode; however, the potential reduction in spending is offset in-part by site-of-care payment differentials and a shift toward more intensive services, particularly for E&M services.

6.2 Changes in Physician Referrals

In this section, we consider potential changes in types of providers (i.e., integrated versus non-integrated) within an episode. We begin by identifying all providers visited within each episode and classifying each provider as either integrated or not integrated with the same hospital system as the focal inpatient hospital. We sum all spending and quantity measures among integrated and non-integrated providers, and we re-estimate the effects of integration separately for each provider type. All estimates again employ our IV strategy discussed in Section 4.

We present results in Table 6, where we find that the overall increase in spending can be decomposed into a large increase in spending among integrated providers of $3,100 per episode, offset by a reduction of around $2,800 in spending to non-integrated providers. We similarly estimate a large increase in work RVUs among integrated providers, with a decrease in work RVUs for non-integrated providers; however, in this case, the increase in work RVUs of 14 among integrated providers far exceeds the 10 unit decrease in work RVUs for non-integrated providers. Results for count of services reveal an almost one-for-one offset among integrated versus non-integrated providers, while results for visits and count of claims suggest a more than one-for-one offset, with decreases to non-integrated providers slightly exceeding the increases to integrated providers.

In general, these results show that patients are much more likely to stay "in the system" throughout the episode of care when the episode is initiated by a vertically integrated physician-hospital pair. This adjustment to referral patterns significantly increases the revenue and quantity of services to the vertically integrated system while similarly decreasing revenue and quantity of services to other non-integrated providers. We conclude that vertical integration is a strong mechanism by which hospitals appear to gain influence over health care delivery within an episode.[22]

7 Integration and Physician Effort

As highlighted in Section 2, integration will tend to remove a physician's individual profit motives and may therefore change the amount of care provided. In this section, we examine the effects of physician-hospital integration on physician-level spending, work RVUs, number of patients seen, and total count of claims. Our regression analysis is analogous to that in Equation 3, only at the physician level rather than the episode level, and we again employ an instrumental variables estimation strategy as outlined in Section 4. Note that this analysis is based on supplemental claims data encompassing 100% of all claims for each physician and is therefore not limited to a 20% sample of Medicare beneficiaries. Nor are these data limited to planned and elective procedures.

Results are summarized in Table 7, with all outcomes expressed in logs. The top panel of Table 7 presents overall results and estimates specifically by location of service, while the bottom panel

[22]We also acknowledge that changes in physician referrals could instead reflect an information channel. For example, integrated physicians now have access to new information regarding quality of care and availability of other providers within the system. While it is beyond the scope of our paper to disentangle the role of information from pure hospital, we also note that the information channel is unlikely to drive our results since we find no evidence of a meaningful change in quality of care.

presents results for specific HCPCS codes. From the first row of the top panel, we estimate an increase of nearly 13% in annual spending per physician, an increase of 20% in work RVUs and count of patients, and almost no change in total number of claims. When we separate claims by location of service, we estimate a large increase in inpatient and outpatient services, with a large decrease in office-based services. The substitution into outpatient services from office-based services is again consistent with prior results. Coupled with the increase in inpatient services, these results suggest a re-orientation of care delivery toward inpatient procedures and generally more intensive services.

The shift toward more intensive services is more apparent in the bottom panel of Table 7, where we estimate effects of integration separately by HCPCS code. We limit this analysis to the top 10 most frequently occurring HCPCS codes in our data. Here, a common theme is that, among groups of HCPCS codes, physicians tend to shift toward the more intensive codes after integration. For example, consider HCPCS codes 99203 ("new patient office visit, 30-44 minutes") and 99204 ("new patient office visit, 45-59 minutes"). In this case, we estimate a 54% reduction in spending for code 99203 alongside an 82% increase in spending for code 99204. Similarly, we estimate a nearly 30% reduction in spending on code 99212 ("established patient office visit, 10-19 minutes") and a 34% increase in spending on code 99214 ("established patient office visit, 30-39 minutes"). Finally, we also estimate large increases in spending and utilization on E& M visits within the inpatient setting (codes 99222 and 99223), including increases in E& M visits within the inpatient setting that require "moderate medical decision making" (code 99232) or "high-level medical decision making" (code 99233) rather than the baseline "straightforward or low medical decision making" (code 99231).

Collectively, these results reveal a relatively nuanced effect of integration on physician effort, with increases in spending, RVUs, and unique patients seen, but essentially null effects on total claims submitted. Our estimates specifically at the inpatient setting and by HCPCS code suggest that physicians re-orient toward more profitable and more intensive services after integration. These results also suggest some evidence of upcoding, especially given the increase in codes for longer visits and the increase in codes requiring higher level medical decision making. That said, we cannot rule out more innocuous explanations. For example, our results may be due in-part to changes in overall patient mix after integration or simply from physicians legitimately spending more time with patients once integrated. We also note these results are somewhat incomplete in that we only observe claims for Medicare FFS beneficiaries. We therefore cannot speak to the potential substitution between Medicare FFS patients and Medicare Advantage beneficiaries or commercial insurance patients.

8 Discussion

By vertically integrating with physician practices, hospitals and physicians become more financially integrated and to some degree share in the combined profits from hospital care and physician services—though not necessarily in a well-defined and easily contracted way. Compared to an independent or group practice not otherwise owned by a hospital system, vertical integration introduces potential pressure from the hospital system for a physician to change their treatment patterns to better align with the preferences and financial interests of the hospital. Some of these pressures may be purely cost reducing, such as adopting a standard medical device across physicians for a given procedure (Craig *et al.*, 2021); however, other pressures may increase treatment intensity or reallocate care to different and higher reimbursing settings. Any such influences are also taking place against a backdrop of the newly formed employer-employee relationship, which can change physician incentives for billable activity effort, irrespective of hospital motivations or actions. The overall effect of these different and sometimes opposing forces is consequently an empirical question.

In this paper, we use Medicare FFS claims from a 20% sample of Medicare beneficiaries to construct measures of spending and utilization for 90-day episodes of care. We focus our analysis on the effects of vertical integration between physicians and hospitals on episode-level spending and utilization. Our preferred results are those from an instrumental variables analysis in which we exploit a plausibly exogenous price shock to physician fee schedules in 2010 as an instrument for downstream physician-hospital vertical integration. Using our IV estimates, we estimate increases in overall Medicare spending, with particularly pronounced increases in outpatient services and spending alongside large reductions in office-based services. Our results for service counts and claims suggest less intensive treatment bundles, on average, after hospital-physician integration; however, episode spending ultimately increases due in part to site-of-care payment differentials and a substitution toward higher intensity services.

Turning specifically to the issue of hospital influence following the acquisition of their practice, we also investigate changes in referral patterns for vertically integrated physicians. Here, we find strong evidence that vertical integration shapes referral patterns within an episode, wherein patients are much more likely to visit another integrated provider under common hospital ownership when the episode is initiated by a vertically integrated physician-hospital pair. This is consistent with hospitals exercising more influence over treatment patterns for additional financial gain—approximately \$3,100 on average in our analyses, which is largely offset by a reduction in spending to other, non-integrated providers.

Beyond within-bundle treatment intensity and spending changes, our estimates also reveal that the newly integrated surgeons shift care toward more intensive services, including an increase in inpatient procedures and an increase in more intensive HCPCS codes. Interestingly, while integrated physicians tend to increase total annual spending, work RVUs, and unique patients seen, we find essentially null results on the effects of integration and total physician claims, suggesting a relatively nuanced effect of integration on total physician effort.

Finally, note that we find no evidence of meaningful effects of vertical integration on quality, measured using readmission rates, mortality rates, or incidence of complications following our clinical episodes of interest. Our key contribution is therefore to show the overall effect of hospital-physician integration on spending and utilization for well-defined treatment episodes, allowing for the combination of favorable reimbursement policy (which tends to increase Medicare payments following integration) as well as changes in care quantities due to the change in the physician's affiliation or employment with the hospital. Hospitals successfully capture new revenue streams by becoming the residual claimant on care provided by the newly owned physician and shifting some of their referrals toward other providers within the overarching firm. These findings, coupled with other known effects of vertical integration (e.g., increased bargaining power and higher prices), also encourage greater attention by regulators and antitrust authorities to hospital acquisitions of physician practices. Our findings also speak to contemporary Medicare payment policy debates and anticipated fiscal impacts, especially when the proposed reforms focus on site-of-care reimbursement rules. In particular, our findings suggest that site-neutral payment is limited in generating cost savings for Medicare due to changes in care delivery along other dimensions.

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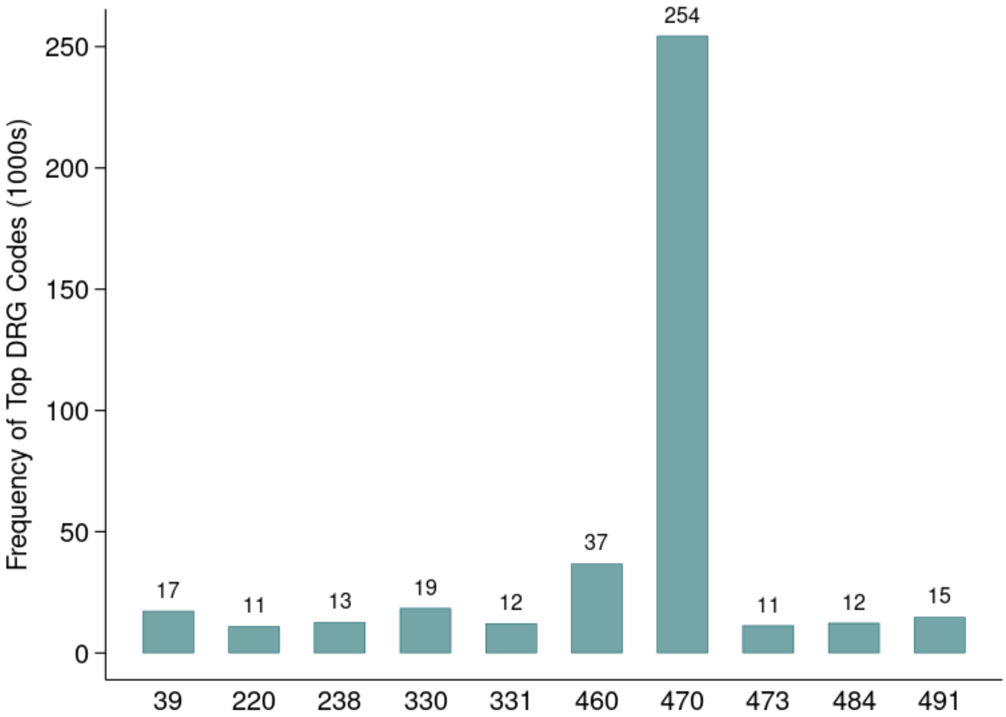
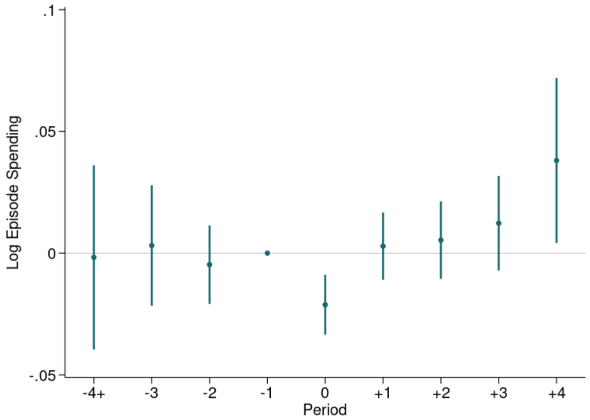
Tables and Figures

Figure 1: **Top 10 DRGs**[a]

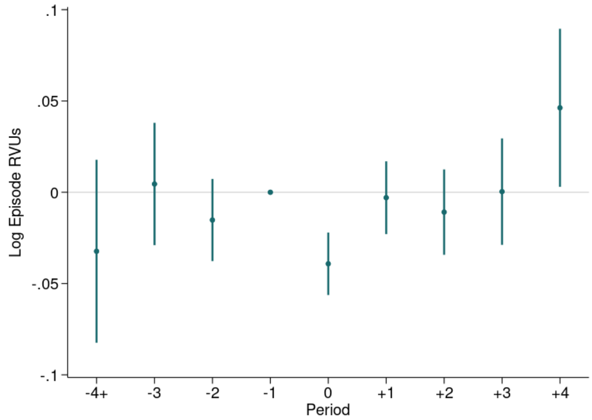


[a]Frequency of most common DRGs associated with the initial inpatient stay of an episode. For a comprehensive list of DRGs and descriptions, see http://data.nber.org/drg/drgdesc11.pdf.

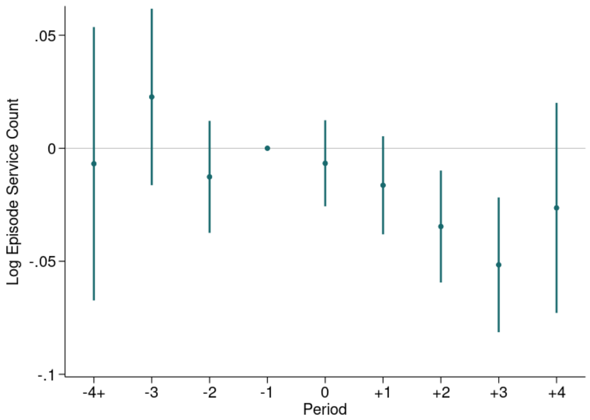
Figure 2: **Event Studies**[a]



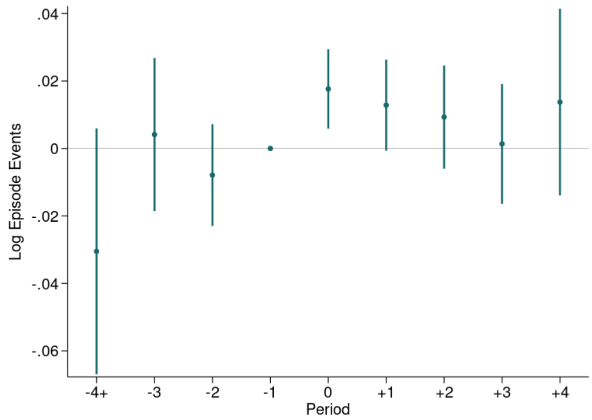
a. Total Spending



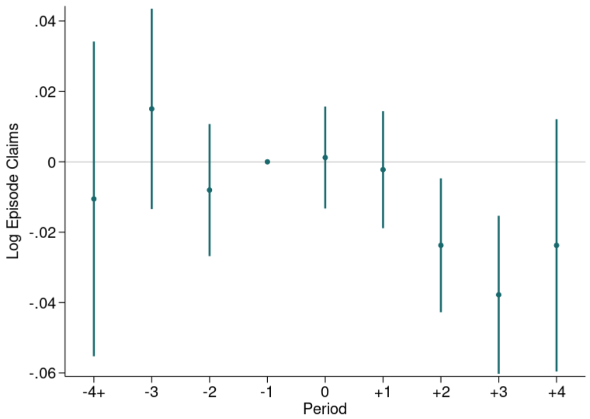
b. Work RVUs



c. Service Count



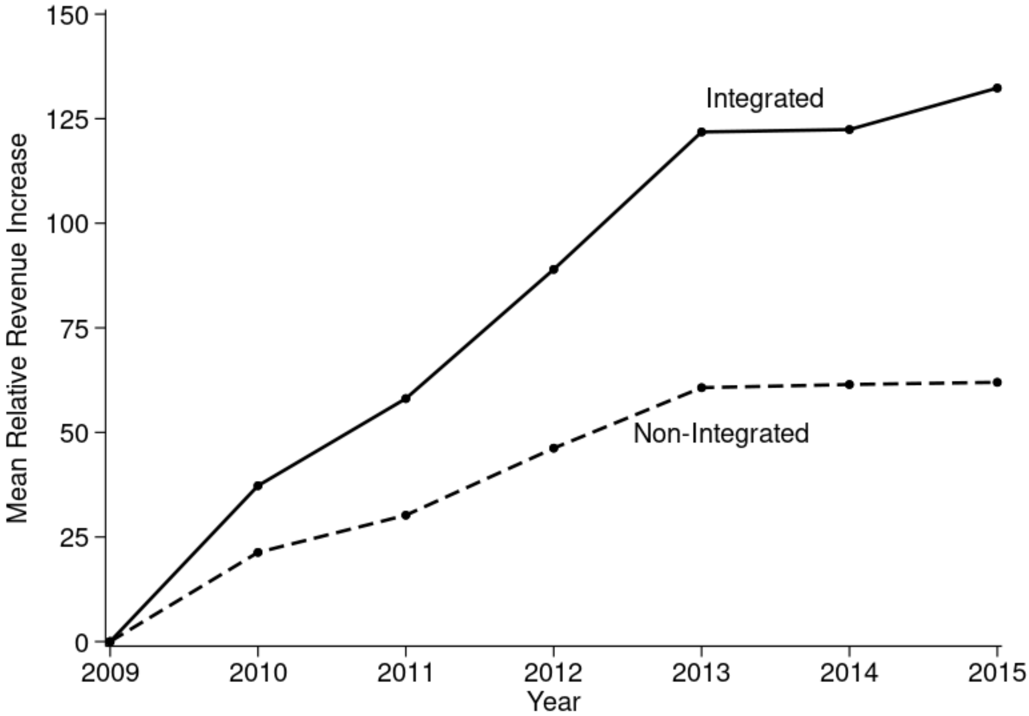
d. Visits



e. Claims

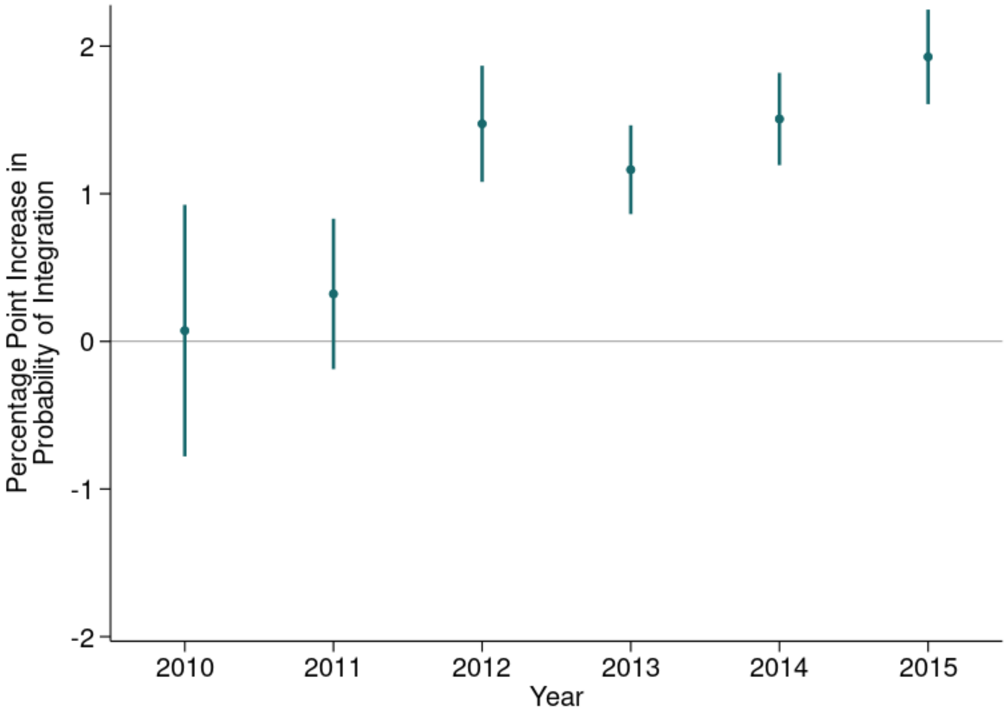
[a]Figures present the results of yearly ATTs based on the repeated cross-section version of Callaway & Sant'Anna (2021), without adjustment for hospital-physician fixed effects. Period 0 denotes the first year of integration.

Figure 3: **Physician-level PPIS Relative Revenue Change**[a]



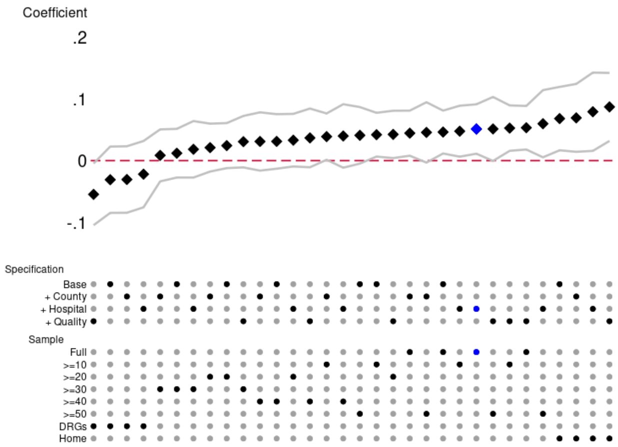
[a]Mean revenue change calculated from Equation 4 in the text. "Integrated" denotes physicians that are vertically integrated at some point over our panel, and "non-integrated" denotes physicians that are never integrated in our data.

Figure 4: **Estimates from LPM of Vertical Integration**[a]

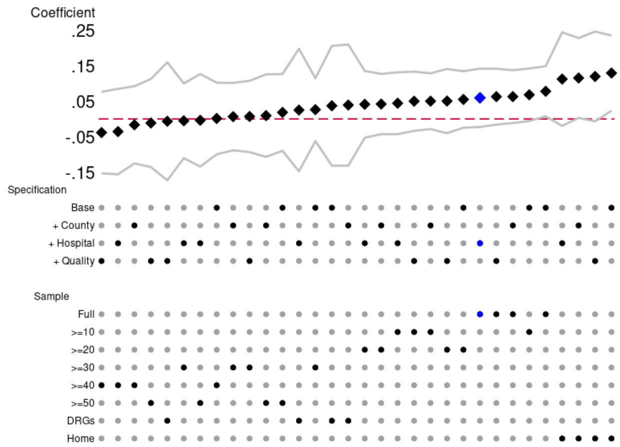


[a]Point estimates and 95% confidence intervals for the coefficients on $\Delta\text{Revenue}_{j,t}^{2010} \times 1(t)$ based on a linear regression of physician integration on $\Delta\text{Revenue}_{j,t}^{2007}$, $\Delta\text{Revenue}_{j,t}^{2010}$, year dummies, and interactions of year dummies on the revenue change variables, $\Delta\text{Revenue}_{j,t}^{2007} \times 1(t)$ and $\Delta\text{Revenue}_{j,t}^{2010} \times 1(t)$. The revenue change variables are defined explicitly in Equation 4.

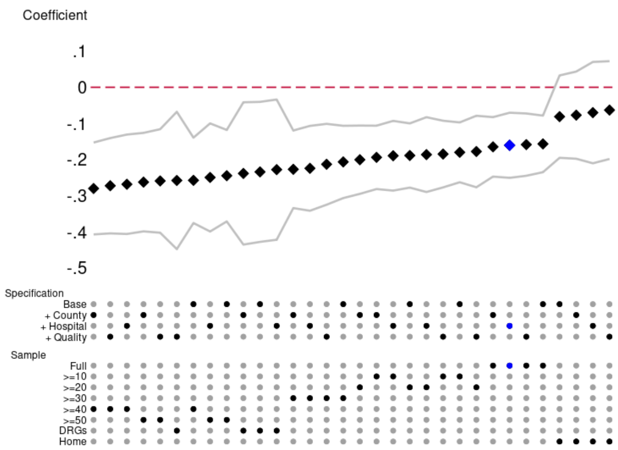
Figure 5: **Specification Curves for IV Estimates**[a]



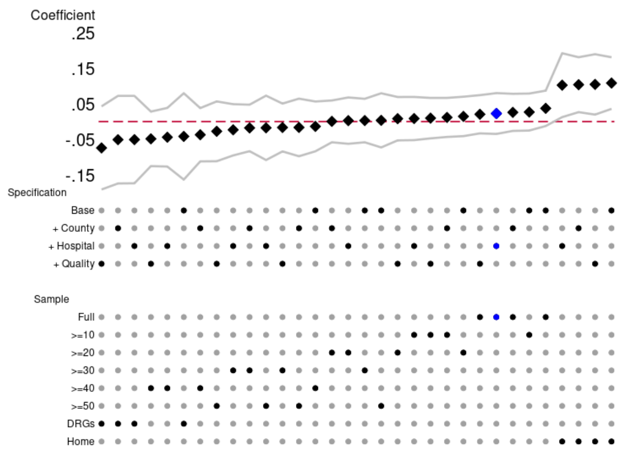
a. Episode payments



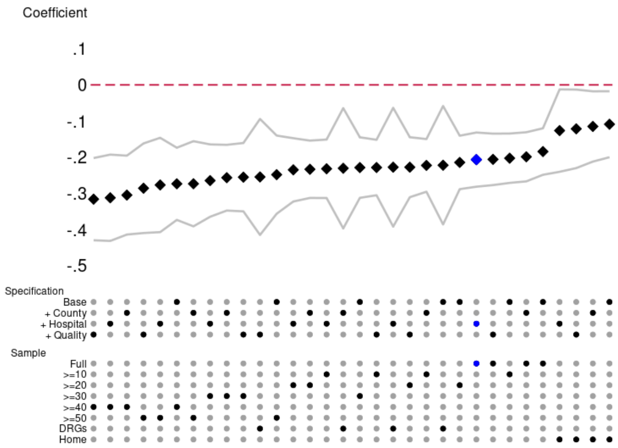
b. Work RVUs



c. Service Count



d. Visits



e. Claims

[a]Point estimates and 95% confidence intervals for the coefficient on physician-hospital vertical integration estimated using IV. County, hospital, and quality covariates follow from Table 4. "Full" denotes the full sample, which is the sample underlying the results in the main text; "$>= 10$" through "$>= 50$" denote restrictions on the minimum number of episodes per physician-hospital pair in the estimation sample; "DRGs" denotes the sample that is restricted to major joint replacements; and "Home" denotes a sample that is restricted to patients discharged to home. The code for our specification curves was adapted from Hans S. Sievertson, who kindly made his code available at github.com/hhsievertsen/speccurve.

Table 1: **Descriptive Statistics per Episode**[a]

	2010	2011	2012	2013	2014	2015	Total	Total No VI	Total VI
Spending	$29,143	$30,050	$30,414	$31,066	$31,991	$31,961	$30,599	$29,316	$34,011
	($21,150)	($21,579)	($21,764)	($21,615)	($21,777)	($21,621)	($21,590)	($20,406)	($24,131)
Visits	22.322	22.611	22.762	22.789	23.068	23.277	22.750	22.468	23.501
	(13.743)	(13.863)	(13.917)	(13.835)	(13.886)	(13.796)	(13.843)	(13.602)	(14.438)
RVUs	85.306	85.846	86.092	87.026	88.941	87.612	86.632	86.710	86.426
	(68.081)	(68.024)	(67.166)	(67.729)	(67.802)	(66.619)	(67.657)	(67.133)	(69.032)
Service Count	92.097	91.816	93.922	93.114	95.666	94.214	93.307	95.083	88.583
	(134.224)	(133.630)	(135.669)	(131.100)	(134.985)	(133.601)	(133.917)	(135.919)	(128.318)
Claims	63.179	63.209	64.229	65.548	67.310	66.472	64.746	65.046	63.946
	(46.571)	(46.218)	(46.420)	(46.385)	(47.190)	(46.436)	(46.551)	(46.565)	(46.505)
Mortality	0.041	0.041	0.041	0.038	0.036	0.036	0.039	0.039	0.041
	(0.199)	(0.198)	(0.199)	(0.191)	(0.185)	(0.186)	(0.194)	(0.193)	(0.198)
Readmission	0.197	0.196	0.186	0.176	0.172	0.166	0.184	0.179	0.198
	(0.398)	(0.397)	(0.389)	(0.381)	(0.377)	(0.372)	(0.388)	(0.383)	(0.399)
Sepsis	0.038	0.038	0.037	0.037	0.038	0.032	0.037	0.036	0.039
	(0.191)	(0.192)	(0.189)	(0.188)	(0.190)	(0.176)	(0.189)	(0.187)	(0.194)
SSI	0.028	0.029	0.028	0.028	0.027	0.022	0.027	0.026	0.030
	(0.166)	(0.168)	(0.164)	(0.164)	(0.163)	(0.148)	(0.163)	(0.160)	(0.171)
Any Complication	0.061	0.062	0.060	0.058	0.059	0.050	0.059	0.057	0.063
	(0.240)	(0.241)	(0.237)	(0.234)	(0.236)	(0.218)	(0.236)	(0.233)	(0.243)
Integrated	0.118	0.187	0.306	0.346	0.385	0.396	0.273		
	(0.323)	(0.390)	(0.461)	(0.476)	(0.487)	(0.489)	(0.446)		
Observations	183,791	171,840	161,278	147,311	134,827	99,107	898,154	652,762	245,392

[a]Mean values by year calculated across all episodes, with standard deviations in parenthesis. In order to allow for a full 90-day episode, we exclude all episodes initiated after September 2015.

Table 2: **Descriptive Statistics per Physician**[a]

	2010	2011	2012	2013	2014	2015	Total	Total No VI	Total VI
Episodes	4.575	4.568	4.646	4.687	4.735	4.078	4.566	4.595	4.493
	(6.058)	(6.074)	(6.267)	(6.487)	(6.619)	(5.437)	(6.183)	(6.396)	(5.620)
Practice Size	11.300	12.686	13.203	13.042	12.466	11.986	12.488	7.969	22.087
	(30.343)	(34.447)	(36.817)	(34.670)	(32.358)	(30.110)	(33.445)	(14.667)	(53.873)
Experience	22.273	23.253	23.201	24.245	24.179	25.508	23.709	23.919	23.265
	(6.257)	(6.357)	(6.384)	(6.473)	(6.423)	(6.475)	(6.466)	(6.808)	(5.649)
Includes PCP	0.042	0.041	0.037	0.028	0.025	0.022	0.033	0.038	0.023
	(0.200)	(0.197)	(0.188)	(0.166)	(0.157)	(0.147)	(0.179)	(0.191)	(0.149)
Multi-specialty	0.265	0.218	0.255	0.268	0.352	0.358	0.281	0.223	0.402
	(0.441)	(0.413)	(0.436)	(0.443)	(0.478)	(0.479)	(0.449)	(0.417)	(0.490)
Integrated	0.123	0.196	0.319	0.366	0.401	0.420	0.287		
	(0.329)	(0.397)	(0.466)	(0.482)	(0.490)	(0.494)	(0.452)		
Observations	40,169	37,622	34,715	31,429	28,472	24,302	196,709	140,209	56,500

[a]Mean values by year calculated across unique physicians, with standard deviations in parenthesis. In order to allow for a full 90-day episode, we exclude all episodes initiated after September 2015.

Table 3: **Descriptive Statistics per Hospital**[a]

	2010	2011	2012	2013	2014	2015	Total	Total No VI	Total VI
Episodes	64.173	59.895	57.868	55.906	52.687	39.675	55.401	27.747	72.945
	(90.330)	(85.343)	(81.424)	(77.488)	(72.988)	(54.615)	(78.754)	(44.513)	(89.930)
Nurse FTEs	371.01	378.36	387.44	404.00	424.72	450.95	401.29	204.10	526.39
	(464.79)	(483.66)	(502.42)	(523.53)	(544.54)	(575.69)	(515.80)	(233.02)	(600.07)
Other FTEs	784.86	798.95	808.68	828.89	853.65	901.66	827.46	420.55	1,086
	(981.93)	(1,031)	(1,0701)	(1,093)	(1,123)	(1,177)	(1,079)	(461.21)	(1,263)
Bed Size (100s)	2.062	2.071	2.065	2.111	2.152	2.219	2.111	1.286	2.634
	(2.080)	(2.097)	(2.130)	(2.192)	(2.221)	(2.297)	(2.167)	(1.293)	(2.431)
For-profit	0.174	0.176	0.173	0.175	0.174	0.170	0.174	0.282	0.105
	(0.379)	(0.381)	(0.379)	(0.380)	(0.379)	(0.376)	(0.379)	(0.450)	(0.307)
System Affiliation	0.608	0.625	0.649	0.659	0.679	0.694	0.651	0.627	0.666
	(0.488)	(0.484)	(0.477)	(0.474)	(0.467)	(0.461)	(0.477)	(0.484)	(0.472)
Major Teaching	0.084	0.086	0.084	0.088	0.084	0.088	0.086	0.011	0.133
	(0.278)	(0.280)	(0.277)	(0.283)	(0.278)	(0.284)	(0.280)	(0.103)	(0.340)
Integrated	0.436	0.498	0.648	0.691	0.720	0.709	0.612		
	(0.496)	(0.500)	(0.478)	(0.462)	(0.449)	(0.454)	(0.487)		
Observations	2,864	2,869	2,787	2,635	2,559	2,498	16,212	6,293	9,919

[a]Mean values by year calculated across unique hospitals, with standard deviations in parenthesis. In order to allow for a full 90-day episode, we exclude all episodes initiated after September 2015.

Table 4: **Instrumental Variables Estimates**[a]

	(1)	(2)	(3)	(4)	(5)
Total Spending	0.048***	0.046***	0.044**	0.051**	0.053***
	(0.018)	(0.018)	(0.019)	(0.020)	(0.018)
Work RVUs	0.076**	0.078**	0.063*	0.060	0.063
	(0.036)	(0.036)	(0.038)	(0.042)	(0.040)
Service Count	-0.168***	-0.157***	-0.165***	-0.160***	-0.159***
	(0.040)	(0.040)	(0.042)	(0.046)	(0.044)
Visits	0.037	0.037	0.026	0.023	0.021
	(0.026)	(0.025)	(0.027)	(0.029)	(0.027)
Claims	-0.191***	-0.184***	-0.199***	-0.207***	-0.206***
	(0.033)	(0.033)	(0.035)	(0.038)	(0.036)
Observations	881,914	872,678	872,678	872,678	872,678
Physician and Hospital FE	X				
Physician-Hospital FE		X	X	X	X
Year FE	X	X	X	X	X
Month FE	X	X	X	X	X
Patient Vars	X	X	X	X	X
County Vars			X	X	X
Hospital Vars				X	X
Quality Vars					X

[a]Results from instrumental variables with fixed effects and covariates as indicated. Standard errors are in parenthesis, clustered by physician. We instrument for the vertical integration indicator as discussed in Section 4. Patient covariates include indicators for the DRG code of the initial inpatient stay and dummies for the quantile of the beneficiary's prior health care utilization. County covariates consist of demographic variables (total population, age distribution, income distribution, and education), dummies for whether the county hospital market is a monopoly, duopoly, or triopoly. Hospital covariates include the number of full-time equivalent (FTE) nurses, the number of FTE other medical staff, and indicators for whether the hospital is part of a larger system, for-profit versus not-for-profit ownership, designation as a major teaching hospital, and an indicator for whether the hospital owns *any other* physician practice. * p-value <0.1, ** p-value <0.05, *** p-value <0.01

Table 5: **Effects on Place and Type of Service**[a]

	Spending	Work RVUs	Service Count	Visits	Claims
Location of Service					
Inpatient	591.767	2.420	-4.620***	0.400	0.710
	(450.417)	(2.458)	(1.150)	(0.301)	(0.617)
Outpatient	452.871***	1.505**	0.045	0.926***	1.031***
	(173.571)	(0.606)	(0.384)	(0.309)	(0.366)
Office	-38.379	-1.067***	0.886	-0.903***	-0.900**
	(90.170)	(0.412)	(4.515)	(0.271)	(0.360)
HHA	101.197	0.015	0.125***	0.058**	0.055**
	(66.780)	(0.013)	(0.033)	(0.026)	(0.026)
SNF	-276.489	-0.268	-0.120	-0.102	-0.117
	(250.697)	(0.202)	(0.149)	(0.128)	(0.135)
Type of Service					
All Professional Services	60.503	2.876	-7.352	0.003	-13.693***
	(179.312)	(2.726)	(5.715)	(0.454)	(1.946)
E & M	256.433***	5.905***	-3.108***	-0.185	-3.371***
	(68.685)	(1.383)	(0.820)	(0.358)	(0.800)
Imaging	-32.920	-0.131	0.366	0.085	-0.832**
	(20.376)	(0.231)	(0.938)	(0.178)	(0.335)
Labs	-0.953	-0.008	0.293	0.460***	0.360
	(17.324)	(0.131)	(0.607)	(0.161)	(0.504)
Observations	872,678	872,678	872,678	872,678	872,678
Physician-Hospital FE	X	X	X	X	X
Year FE	X	X	X	X	X
Month FE	X	X	X	X	X
Patient Vars	X	X	X	X	X
County Vars	X	X	X	X	X
Hospital Vars	X	X	X	X	X

[a]IV results for the coefficient on hospital-physician vertical integration, where we instrument for the vertical integration indicator as discussed in Section 4. Values above the 99th percentile are winsorized. Included covariates and fixed effects follow from Table 4. Standard errors in parentheses, clustered by physician. * p-value <0.1, ** p-value <0.05, *** p-value <0.01

Table 6: **Effects on Referral Patterns**[a]

	Spending	Work RVUs	Service Count	Visits	Claims
Integrated	3,102***	13.977***	7.910***	5.250***	5.704***
	(321.24)	(1.654)	(1.100)	(0.463)	(0.506)
Non-Integrated	-2,827***	-8.964***	-7.685**	-6.194***	-6.615***
	(339.35)	(1.738)	(3.221)	(0.597)	(0.646)
Observations	872,678	872,678	872,678	872,678	872,678
Physician-Hospital FE	X	X	X	X	X
Year FE	X	X	X	X	X
Month FE	X	X	X	X	X
Patient Vars	X	X	X	X	X
County Vars	X	X	X	X	X
Hospital Vars	X	X	X	X	X

[a]IV results for the coefficient on hospital-physician vertical integration. Values above the 99th percentile are winsorized, and we instrument for the vertical integration indicator as discussed in Section 4. Outcomes consist of all inpatient, outpatient, and professional services claims. Standard errors in parentheses, clustered by physician. Included covariates and fixed effects follow from Table 4. * p-value <0.1, ** p-value <0.05, *** p-value <0.01

Table 7: **Effects on Total Physician Effort per Year**[a]

	Spending	Work RVUs	Patients	Claims
Total	0.129***	0.210***	0.216***	0.005
	(0.031)	(0.029)	(0.027)	(0.035)
Inpatient	0.101***	0.123***	0.204***	0.117***
	(0.038)	(0.033)	(0.038)	(0.033)
Outpatient	0.182**	0.402***	0.123*	0.180**
	(0.080)	(0.082)	(0.069)	(0.077)
Office	-0.609***	-0.581***	-0.972***	-1.012***
	(0.210)	(0.175)	(0.189)	(0.205)
Observations	174,538	174,538	174,538	174,538
Services by HCPCS Code				
99203	-0.540***	-0.364***	-0.351***	-0.350***
(n=147,598)	(0.102)	(0.089)	(0.086)	(0.086)
99204	0.816***	0.859***	0.803***	0.801***
(n=138,911)	(0.107)	(0.100)	(0.093)	(0.093)
99212	-0.292**	-0.017	-0.047	-0.028
(n=140,611)	(0.115)	(0.092)	(0.094)	(0.101)
99213	0.015	0.145**	0.147**	0.148**
(n=164,621)	(0.078)	(0.072)	(0.065)	(0.072)
99214	0.338***	0.434***	0.397***	0.422***
(n=156,148)	(0.084)	(0.078)	(0.070)	(0.076)
99222	1.310***	1.275***	1.137***	1.175***
(n=117,992)	(0.152)	(0.138)	(0.123)	(0.126)
99223	0.890***	0.838***	0.741***	0.763***
(n=104,214)	(0.151)	(0.135)	(0.104)	(0.106)
99231	-0.089	0.105	0.051	0.095
(n=97,344)	(0.181)	(0.110)	(0.117)	(0.140)
99232	0.295**	0.237**	0.195**	0.234**
(n=114,050)	(0.138)	(0.141)	(0.092)	(0.107)
99233	1.202***	0.991***	0.833***	0.949***
(n=72,424)	(0.182)	(0.141)	(0.110)	(0.132)
Physician FE	X	X	X	X
Year FE	X	X	X	X
County Vars	X	X	X	X
Physician Vars	X	X	X	X

[a]IV results for the coefficient on physician-level vertical integration, where we instrument for the vertical integration indicator as discussed in Section 4. Outcomes consist of all claims on which the operating physician is listed as the billing physician. Covariates include all county-level variables and mean patient-level variables described in Section 4, as well as physician fixed effects, with standard errors clustered by physician. * p-value <0.1, ** p-value <0.05, *** p-value <0.01