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The Effect of Hospital Acquisitions of Physician Practices on Prices and Spending

Cory Capps
Partner, Bates White Economic Consulting

David Dranove
Walter J. McNerney Professor of Health Industry Management
Faculty Associate, Institute for Policy Research
Kellogg School of Management, Northwestern University

Christopher Ody
Research Assistant Professor of Strategy
Kellogg School of Management, Northwestern University

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2040 Sheridan Rd. ◆ Evanston, IL 60208-4100 ◆ Tel: 847-491-3395 Fax: 847-491-9916
www.ipr.northwestern.edu ◆ ipr@northwestern.edu

Abstract

One of the most important recent trends in the U.S. healthcare industry is hospital acquisition of physician practices. From 2007 to 2013, nearly 10 percent of physicians in the researchers' sample were acquired by a hospital, increasing the share of physicians that are hospital owned by more than 50 percent. Supporters of hospital-physician integration argue that it offers the promise of significant cost savings while opponents raise concerns that integration will result in higher prices. Despite the heightened interest in hospital-physician integration, the research evidence is mixed and of questionable quality. Prior studies suffer from significant data problems that the researchers overcame by using administrative claims data provided by one or more anonymous insurer(s) operating in a number of states. With their data, they are able to (a) identify physician integration at the level of the individual practice, (b) study provider transaction prices before and after integration, and (c) examine broader medical spending. Capps, Dranove, and Ody find that, on average, physician prices increase nearly 14 percent post-integration—roughly a quarter of this increase is attributable to the exploitation of payment rules—and that price increases are larger when the acquiring hospital has a larger share of its inpatient market. They find no evidence that integration leads to reductions in spending, even four years post-integration.

The Effect of Hospital Acquisitions of Physician Practices on Prices and Spending

I. Introduction

Over the past decade, there has been a steady decline in the percentage of physicians in groups of ten or less, and a steady increase in the percentage in large groups of 151 or more (Burns et al., 2013). An increasing percentage of these groups are owned by hospitals. (Kocher & Sahni, 2011; Merritt Hawkins, 2014; Welch et al., 2013). Many analysts have expressed concerns that this integration will drive up health care spending. For example, based on a set of site visits, O'Malley et al. (2011) concluded that hospital acquisitions of physician groups had, to date, primarily advanced strategies to increase the acquiring hospitals' fee-for-service volume, both through increased referrals and greater per patient service volume through, for example, increased testing. Burns, Goldsmith, and Sen (2013) reach a similar conclusion, as do Baker, Bundorf, and Kessler (2014). Integration could also drive up spending if it increased provider bargaining power (Dafny, Ho, and Lee, 2014) or if it allowed hospitals to exploit contracting provisions that allow billing of services at generally higher hospital rates (i.e., hospital-based billing).

Supporters of hospital-physician integration (which is also referred to as "Vertical Integration" or simply VI) counter that it offers the promise of significant cost savings through care coordination and other efficiencies. And, indeed, there is a large literature arguing that more coordinated care would or could result in lower healthcare costs and improved quality (Shih et al, 2008; Enthoven, 2009; Fisher et al., 2009; Stange, 2009; Yong et al., 2010). However, that same literature generally does not advance hospital-physician integration as the only, or even the preferred, organizational form for reducing care fragmentation. For example, Shortell and Casalino (2008) describe five alternative organizational models of "accountable care systems," their term for systems that deliver coordinated care to patients. Only one of those five models is a vertically-integrated structure in which hospitals and physician groups are jointly owned. Nevertheless, because hospital-physician integration is one possible path towards less fragmented and higher value care, merging parties in recent vertical hospital-physician merger investigations and litigation have argued that a merger will allow them to achieve care delivery efficiencies that could not otherwise be obtained. Recent examples include the St. Luke's-Saltzer acquisition in Idaho and the Partners-South Shore merger in Massachusetts (these particular "vertical" mergers also entail horizontal overlap).

Despite the heightened interest in hospital-physician integration, the research evidence on its effects is thin. A few studies examine the impact on hospital prices, but none to our knowledge study physician prices. Only a few studies examine total health spending. Moreover, these studies generally suffer from numerous data limitations. For example, prior pricing studies have relied on broad and sometimes misleading definitions of hospital-physician integration, and have computed average prices from aggregated claims data. This has made it difficult for researchers to identify merging parties and measure actual transaction prices or overall medical spending. At the same time, prior cost studies tend to focus on cross-section comparisons and, as a result, may omit important but unobservable control variables, resulting in endogeneity bias.

In this study, we overcome these problems by using seven years of administrative claims data provided by several insurers operating in a number of states. With this data, we are able to both (a) identify physician integration at the level of the individual practice, (b) study physician transaction prices before and after integration, and (c) study total health spending before and after integration. We find that from 2007-2013 there has been a substantial amount of VI, with the share of spending by physicians whose practices are owned by hospitals increasing from 16.9 percent to 26.5 percent, an increase of 9.6 percentage points or 57 percent.

These acquisitions lead to substantial price increases for the acquired physician groups, with average prices per unit of service increasing by 13.7 percent. These price increases vary substantially across specialties, with PCP prices increasing by 11.7 percent and prices for cardiologists increasing by 34.3 percent. As a result of VI, physician prices were approximately 1.3 percent higher in 2013 than they would have been had hospital ownership of physician groups remained at its 2007 level. These price increases do not appear to be explained by "traditional" increases in horizontal market power within physician markets. We find that price increases are larger when the acquiring hospital has a larger share of its inpatient market.[1] Finally, we estimate that approximately one quarter of the price increases are due to increased exploitation of reimbursement rules that allow hospitals to charge "facility fees" for services by hospital owned physicians.

Although VI leads to prices increases, total healthcare expenditures could be flat or even declining if VI leads to reductions in utilization. We find no evidence to suggest

[1] We use the term "market" informally to refer either to the general geographic areas in which providers are located (e.g., the MSA) or the types of services they provide (e.g., hospital or physician). We do not use the term in the formal, antitrust sense.

that VI leads to lower expenditures, and in fact find some evidence to suggest that it leads to higher total expenditures.

II. Vertical Integration and Medical Spending

As summarized in a review by Burns et al. (2013), industry participants offer a variety of reasons for integration. Some rationales comport with standard economic theory. For example, in addition to potentially enhancing market power, horizontal integration may offer economies of scale and scope. Extensive empirical evidence suggests that physicians in group practice are more productive and better able to contain administrative and IT costs that solo physicians. Even so, small groups of 7-10 physicians appear to be more productive than larger groups, indicating that the benefits of scale may quickly diminish. Other rationales for horizontal integration are less grounded in economic theory – for example, integration purportedly allows physicians to manage capitated risk contracts and align strategic purposes (Burns and Pauly, 2002).

Supporters of vertical integration offer many rationales that are even less well grounded in economic theory, including protecting referrals, preparation for accepting global capitation, taking responsibility for the health status of a local population, offering a seamless continuum of care, and expanding the supply of physicians (Burns et al., 2013). Additional goals include defraying IT costs, stabilizing physician incomes, and creating entry barriers. (Goldstein, 2005). Supporters believe that if vertically integrating hospitals can accomplish these goals, the result will be lower total medical expenditures (though not necessarily lower hospital expenditures). Missing from these rationales is an explanation of how joint ownership makes efficient transactions and investments more feasible.

Vertical integration also has its skeptics, and many analysts are concerned that it could lead to higher prices and higher spending. (O'Malley et al., 2011; Burns, Goldsmith, and Sen, 2013; Baker, Bundorf, and Kessler, 2014; Burns and Pauly, 2012; Goldsmith, 2012; Christensen, 2013).

Theory: Vertical Integration and Pricing

Economic theory does not yield clear predictions about the impact of vertical integration on prices. Take what would seem to be a clear cut example, the merger of a monopoly hospital with a monopoly physician group. The "theory of one monopoly rent" suggests that the market power a vertically combined entity is, in effect, the sum of the market power of each individual entity, but no more.[2] Thus, two monopolists in a vertical chain cannot augment their pricing power by merging. Antitrust economists have developed a number of exceptions to this rule, for example when vertical integration facilitates price discrimination or when it facilitates the exclusion of potential competitors (Rasmusen, Ramseyer, and Wiley, 1991; Segal and Whinston, 2000). The application of these antitrust examples to hospital-physician integration is unclear, however. Looking beyond pricing, vertical integration could lead to lower overall expenditures if it leads to more efficient production of hospital services.

More recent work shows that the combination of selective contracting (the process through which insurers negotiate rates with providers Capps et al. (2002)) and

[2]See for example, Bork(1978)

imperfect competition among downstream insurers (who are themselves not perfectly able to price discriminate among consumers) might enable vertically integrating healthcare providers to raise their prices. Gal-Or (1999) shows that vertical integration can lead to higher rates if the hospital and physician face similar competitive circumstances prior to the merger. Vistnes and Sarafidis (2013), Dafny et al. (2014), and Peters (2014) offer several additional reasons. For example, patients might be willing to purchase insurance that lacks access to their preferred hospital *or* their preferred physician, but might be unwilling to purchase insurance lacking access to *both*. This gives the merged entity sufficient leverage to raise price. Unfortunately, these papers do not provide sufficient guidance for identifying *in the data* those situations where integration is most likely to drive prices higher.

There may be simpler institutional reasons why hospital-physician mergers can drive up prices. Many medical services, including diagnostic tests and simple procedures, trigger several bills. One bill is for professional fees meant to cover the physician's effort. Another bill is for facilities fees, meant to cover the cost of equipment and associated expenses. Medicare usually pays higher facilities fee for the same procedure performed at a hospital-owned facility than at a physician-owned facility.[3] Private insurers have largely followed suit. Thus, when a hospital acquires a physician practice, this can automatically trigger higher fees for a given procedure, even when the procedure is performed by the same physician at the same location. Bear in mind that the fees paid by insurers are typically negotiated through multi-year contracts, so that insurers might negotiate lower fees with the merged entity at the end of the contract period. Of course, if the merged

[3]The original justification was to cover higher hospital overhead expenses.

entity has accrued market power, it could resist. In any event, spending would be higher during the interim between the merger and any renegotiation.

Despite the dearth of theory, interest in hospital-physician integration has spurred a number of empirical studies of its effect on price. Cuellar and Gertler (2006) examine hospitals in three states in the mid-1990s, a period during which many hospitals acquired physician practices. Ciliberto and Dranove (2006) examine hospitals in California over a slightly later time period. Baker, Bundorf and Kessler (2014) update the results to include hospitals in 2001-2007, but data restrictions require them to report results at the county level (thus asking what happens to prices in counties that are home to integrating hospitals). All three studies measure price as the average discounted revenues from private payers, and all use fixed effects to identify the effect of integration. Yet the studies yield conflicting results – Cuellar and Gertler find that integration is associated with lower prices, Ciliberto and Dranove find no effect, and Baker et al. find higher prices.

All three studies share a fundamental limitation that we correct in this study. All measure integration by using a classification scheme in the American Hospital Association member survey. Hospitals identify whether they have salaried physicians and/or other forms of integration, but do not identify the extent of these relationships. Thus, a hospital may greatly expand the number of employed physicians over time, but will be reported to have the same degree of vertical integration at all times. In our study, we use tax identification numbers for physicians and hospitals to identify when the latter have acquired the former.

Theory: Vertical Integration and Total Spending

Moving from prices to total spending, economic theory gets even murkier. The underlying issues are whether integration generates efficiencies in the vertical chain, whether those efficiencies are sufficient to offset any unit price effects, and whether vertical integration, as opposed to arms-length relationships or contracting, is necessary to achieve these efficiencies. The economics of vertical integration suggests that mergers could lower total costs if they facilitate relationship specific investments (i.e., investments whose value depends on maintaining the business relationship between the two parties) or reduce coordination costs on design attributes (i.e., features of the trade relationship that are critical to its success). Mergers could drive costs higher if they adversely affect incentives or create bureaucratic costs such as influence activities, in which individuals in the integrated firm inefficiently lobby for organizational resources (Besanko et al., 2012). Note that costs could increase in some parts of the vertical chain (e.g., in hospitals) yet decrease in others (e.g., outpatient care). Advocates of vertical integration believe that total costs will decrease, but do not identify relevant specific assets or design attributes so as to lend theoretical heft to their hope. Nor do they tend to acknowledge potential inefficiencies such as influence activities.

There have been several empirical studies of vertical integration and costs. Allen and Cuellar (2006) find no difference in hospital productivity at integrated and non-integrated hospitals. Baker et al. (2014) find slightly higher hospital spending per privately insured enrollee in counties that are home to integrating hospitals. However, both studies again suffer from the use of the AHA-defined measure of integration, and both also suffer because they only examine prices and spending for hospitals. In addition, the health services research literature offers a large number of cross-section comparisons of vertically integrated and non-integrated hospitals. These studies use a variety of measures of integration, including the AHA measures, but none have direct measures of ownership at the physician level.[4] And nearly all studies focus on hospital expenditures, rather than total spending. Summarizing this literature, Burns et al. (2013) report that "evidence regarding the impact of hospital-physician integration on cost remains scattered and ambiguous."[5]

III. Methods and Data

We obtained administrative claims data for 2007 to 2013 from one or more anonymous insurers (henceforth, "the data provider") doing business in at least several states. Our states contain approximately 12 percent of the U.S. population and are broadly representative – they are geographically dispersed and have a similar household income distribution to the nation as a whole. The population of our states is somewhat older than the U.S. population– approximately 2 percent more of the population in our states is over 65 than in the country as a whole. A population weighted majority of the states in our sample are present for the entire period of 2007-2013, but due to incomplete data some states enter our sample only in later years.

We restrict our analysis to metropolitan statistical areas. We identify individual physicians using their unique national provider identification number (NPI) and we

[4] For example, Goes and Zhan (1995) consider whether physicians sit on the hospital board and whether the hospital bills enter into joint venture arrangements with physicians.
[5] Burns et al. (2013) p. 76.

identify integration activity using tax IDs.[6] When determining ownership or computing prices, we eliminate claims that are missing either of these fields. However, we add these claims in when calculating total spend per enrollee/year.

Measuring VI

As in prior research on vertical integration, the main independent variable in our analysis, VI, measures whether a physician has been acquired by a hospital. Measuring *VI* is a challenge; most prior studies measure *VI* at the hospital level and rely on hospital surveys that indicate whether the hospital is engaged in any integration. These studies do not identify the extent of integration at the hospital level or which specific physicians are integrated. To overcome this problem, we use the tax ID in the claims data to identify ownership and, hence, integration. We define a physician to have become integrated in the first year that the physician (identified by the NPI) has billed for at least 50 percent of allowed charges (i.e., the transaction price, which is the total amount that payers have agreed to pay) under hospital's tax IDs. In addition, we treat a physician as integrated if the most common (based on allowed charges) tax ID that the physician bills under is a hospital's tax ID. We continue to treat physicians as integrated once they have integrated. We exclude from our analysis a small share of physicians who integrated and then unintegrated. Doing so does not substantively change our conclusions.

Ultimately, we assign each physician to a "VI status/tax ID" pair, ensuring that physicians with the same main tax ID in each year have the same integration status in

[6] Approximately 8 percent of the physician revenue is accrued by physicians using group identification numbers (i.e., a physician group has its own NPI and the group's component physicians bill under that NPI). We treat these as unique "physician" observations.

each year. First, we determine whether the physician is vertically integrated as discussed above. We then assign the tax ID that represents the largest share of billings within the assigned VI status. On rare occasions, the VI status/tax ID pair may not coincide with the most frequent tax ID.[7]

Large hospital systems and physician groups often have more than one tax ID. We take a number of steps to aggregate these, both so that we can create system level measures of market power and so that physician groups that are owned by a hospital system but using a separate tax ID are correctly classified as vertically integrated. First, we use data from the American Hospital Association to aggregate different hospitals within a market into systems. Second, we use data from SK&A to map different physician tax IDs into systems. Our SK&A data contain physician National Provider Identifier (NPI) numbers, practice name, hospital owner, and system owner.[8] We merge the SK&A data with our claims data and group tax IDs from our claims data based on the SK&A ownership information. We additionally aggregate tax IDs that are not hospital- or system-owned into group practices based on the SK&A practice name.

Match rates between NPIs in our claims data and the SK&A data are relatively low – matched providers account for only about one third of revenues. By filling in ownership information for NPIs that do not match to the SK&A data but have a tax ID that does match, we increase the match rate to about 55 percent. When we eliminate group practice NPIs, non-physician NPIs (i.e. nurses, suppliers, etc…) and very small

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[7] For example, consider a physician that bills under three VI status/ IDs as follows: VI Yes/Tax ID 1/share 25%; VI Yes/Tax ID 2/share 35%; VI No/Tax ID 3/share 40%. We would assign this physician to VI Yes/Tax ID 1.

[8] We cleaned the SK&A data to ensure a certain degree of internal consistency. For example, we edit the system ownership data to ensure that if a physician reports a hospital owner and that hospital is a part of a system, then the correct system is filled in.

physician groups (tax IDs that have five or fewer NPIs in them), the match rate improves to 78 percent.

Our methodology captures a number of ownership changes that would not be captured using tax ID changes alone. We are in the process of hand checking the largest ownership changes (and will complete this in a later version of this paper). We do this using the IRS 990s (reports that non-profits are required to fill which contain tax IDs and organizational structure), by performing news searches, by visiting the web sites of larger providers, as well as by checking with the data provider. Furthermore, because the SK&A data do not include group practice NPIs, we hand checked many of the largest physician practices to ensure correct assignment of group practices.

Based on this data validation, it appears that the SK&A data contain many false positives, especially in earlier years. (There appear to be improvements in the quality of SK&A data over time.) Often, large, vertically integrated physician groups do not report that they are vertically integrated in the first years of our data, so we likely have some false positives that are due to correctly classifying vertically integrated physicians as vertically integrated after incorrectly classifying them as not integrated. This causes attenuation bias in our estimates, but also (because vertically integrated physicians have faster price growth) may explain why there appear to be pre-trends in some of our analysis.

Controlling for Changes in Competition

Many vertical mergers also have a "horizontal" merger component. Therefore, we will need to control for horizontal concentration of physicians. We do this using a number of steps that are loosely based on Kessler-McClellan (2000). First, we compute the Herfindahl Hirschman Index (HHI) of market structure for each specialty/zipcode/ year combination using allowed payments to physicians to compute shares and accounting for corporate ownership structure (called HHI_{zip1}). Next, we compute physician/year HHIs as a weighted average of the HHIs that the physician serves. Finally, in some analyses, we compute another specialty/zipcode/year HHI which is the weighted average of the physician/year HHIs for the physicians in that zipcode (called HHI_{zip2}).[9] By construction, these HHIs will capture only localized effects of competition on prices.

We construct physician, rather than health care organization, level HHIs because changes of ownership only have one effect on HHIs constructed this way (i.e. they change the HHIs of the zip codes from which that the physician draws patients). In contrast, when constructed using organizations, ownership they have a second effect as well; namely, the acquired (i.e a physician) switches from having the HHI of organization A to the HHI of organization B. This second source of variation is akin to cross sectional variation in HHIs and is likely to suffer from a number of biases. Again, theory provides little empirically actionable guidance about when, whether, or how a firm should spread its rents from market power in some of its lines of business or locations across its broader set of operations.

[9] Our HHI is subject to a number of sources of measurement error and endogeneity. We have confirmed that our main results are robust to instrumenting for HHIs by focusing only on the changes in HHI that are due to larger mergers (Dafny, Duggan, and Ramanarayanan (2012)). For the purposes of this analysis, we only report results using the endogenous measure of HHI as a control.

Constructing Prices

Our data include the transaction price for each service, where services are identified by Current Procedural Terminology (CPT) codes. We aggregate inpatient prices and outpatient prices using slightly different methods, and then compute an overall aggregated price per physician. For services provided on an inpatient basis, we move from service-level pricing to physician-level pricing as follows. First, we sum the prices for all inpatient services provided by an individual physician in a given year. Next, we compute the sum of what Medicare would have paid for the same services in that year. We then compute the ratio of the two, which we label *IPPrice*. Thus, *IPPrice* represents the ratio of the total fees generated by the physician for the insurer in question, relative to what the physician would have been paid had Medicare been the insurer. In addition to collapsing potentially thousands of individual prices into a single price per physician, this measure controls for regional variations in pricing, because Medicare fees are adjusted for regional differences in input costs. Note that private insurers and providers often use the same methodology to aggregate and describe their pricing, often comparing overall prices to what Medicare would pay.

Our method for computing outpatient pricing is a bit more complex because office based services will often generate a single bill for a non-integrated physician, but two distinct bills for an integrated physician. More specifically, Medicare pays two bills when a service is rendered in a hospital (or otherwise subject to hospital-based billing): a "professional fee" for the physician's effort and a "facility fee" for the facility's overhead. In contrast if that same physician provides the same procedure in a private office, Medicare combines payment for the physician's time and overhead into a single professional fee.[10] Private payers sometimes follow Medicare's example. Thus, we combine the professional and facilities fees for the former case, treating any facility spending occurring for the same day and for the same patient as a physician bill as spending attributable to that physician.[11] This is important because if one only examines professional fees, services may appear to be more expensive when performed in the physician's office, leading to the misleading conclusion that vertical integration reduces spending. In reality, the aggregate fee is usually higher when the service is performed in an inpatient or hospital outpatient setting. Once we have computed the appropriate price for each outpatient service, we follow the same aggregation procedure described earlier and compute *OPPrice* as the payment relative to what Medicare would pay for the same service in an office setting. Finally, we aggregate all inpatient and outpatient prices to compute our overall measure *Price.*

To help isolate the role of facility fees in leading to higher prices, we examine the same procedures used to compute *OPPrice*, but compare spending against a different benchmark. Rather than comparing prices against what Medicare would pay in an office setting, we instead compute for bills with a facility charge what Medicare would have paid if the bill was submitted in a facility setting. For bills without a facility charge, we

[10] For vertically-integrated physicians, under certain circumstances, Medicare's rules allow for a physician's office to become a part of the hospital's outpatient department. In these situations, physicians can provide the same care in the same location as before, but the vertically-integrated physician/hospital combination can now submit two bills.

[11] In practice, this is complicated because we need to connect the bill from the facility to the bill from the physician. For each outpatient facility bill, we determine whether any physician submitted a bill for services on the same day. If so, we assign the outpatient facility bill to the "main" physician that the patient used on that day, and simply include those procedures and charges as a part of the physician's bill. Because the same procedure will appear more than once on the combined bill, we code the quantity of a procedure as the maximum of the quantity provided by the physician and facility. To avoid cumbersome language, we refer to all of the spending that is attributable to the physician using this methodology as simply the physician's spending, even though some of the spending attributable to the physician is billed by a facility.

continue to calculate what Medicare would have paid in an office setting. When there is a facility charge, we determine Medicare reimbursements for all facility charges based on Medicare's Outpatient Prospective Payment System (OPPS), and we determine Medicare's prices for all physician charges based on what Medicare would have reimbursed in a facility setting.[12] We create a variable *UpcodeFF*, which gives the percent increase in Medicare reimbursements resulting from using facility based billing over office based billing. In our regressions, we will determine if *UpcodeFF* explains part or all of the increase in private prices.

Our price measures have some notable advantages and limitations. As mentioned earlier, we are measuring transactions prices at the most granular level possible and aggregating in a way that allows us to simplify our analysis by using a well-accepted numeraire – the Medicare price. One limitation is that we are only able to measure prices for approximately 75 percent of the spending attributable to physicians. This is because physicians perform a number of services that are not reimbursed using the physician fee schedule. These include services only reimbursed under the outpatient PPS system, for which there is no appropriate Medicare price as well as certain outpatient drugs (e.g., cancer infusion therapy drugs.)[13]

[12] OPPS uses complicated rules to determine reimbursements for sets of procedures. We follow the main elements of the reimbursement system. For example, a needle may be reimbursable if charged alone, but not reimbursable when charged on the same day as a surgical procedure. We made no attempts to alter the bills to impose any logical consistency between the physician bill and facility bill. Details are available by request.

[13] Another limitation is that Medicare physician office prices for procedures that are almost always performed in hospitals seem to be outliers that make for inappropriate comparisons. As a result, we may grossly misstate price levels for these services both before and after integration. As long as integration does not affect the probability of these types of services being performed, this should not cause bias because we express our prices in logs. Said differently, an X percent price change is an X percent price change regardless of the price level.

The Effect of Vertical Integration on Prices

We use Difference in Differences regression to estimates the effects of integration on prices. The unit of observation is a physician (*p*) at time *t*. We assign each physician to one metropolitan area (*m*) in each year and to one specialty (*s*) across years. Allowing *Y* to be any of our three price variables, α_p to be a physician specific fixed effect, *VI* to be an indicator for whether the physician is vertically integrated, *X* to be a number of additional controls that are included in some specifications (more specifically, *HHI*, *UpcodeFF*, and an interaction between *UpcodeFF* and *VI*), and $\alpha_{[ms]t}$ to be a time fixed effect (in some specifications, we allow for different time trends by metropolitan area, or the Cartesian product of metropolitan area and specialty)[14], we run regressions of the form:

$$\ln(Y_{pt}) = \alpha_p + \alpha_{[ms]t} + \beta VI_{pt} + [\gamma X_{pt}] + \varepsilon_{pt} \qquad (1)$$

We omit the transition year and physicians who were vertically integrated prior to the start of our analysis from the regressions. We cluster our standard errors conservatively, using the Cartesian product of a physician's "main" tax ID in each year and the MSA as the cluster variable. For example, if a physician practice is acquired by a hospital, the entire practice will be treated as one cluster.

The Effect of Vertical Integration on Total Health Spending

Regardless of the effect of integration on pricing, the performance of integration will ultimately be determined by its effects on healthcare expenditures (and, of course,

[14] Because the Cartesian product becomes large, we aggregate specialties that account for less than 2.5% of spending.

quality, which we do not study directly.)   In an experimental setting, one might imagine randomly assigning physicians to VI and non-VI status, randomly "assigning" patients to VI and non-VI physicians, and comparing spending trends for the two groups of patients. The resulting estimates of the effects of VI on spending would be unbiased. In the rest of this section, we describe how we attempt to generate unbiased estimates of the effect of VI in our decidedly non-experimental setting.

Effect of "Main" Primary Care Physician VI on Total Health Spending

As a first step towards identifying the effect of integration on expenditures, we examine how the share of a patient's E&M visits that are to a VI Primary Care Physician (PCP) affects spending. For each patient in each year, we calculate the share E&M visits that are to VI PCPs. Of course, the decision to visit a VI PCP is endogenous. We therefore instrument for the share of PCP visits that a patient receives from a VI PCP with the VI status of that patient's "main" PCP – i.e. the one with whom the patient has the largest number of E&M visits – in the first year in which the patient visits a PCP in the data. This amounts to examining how the integration status of a patient's first "main" PCP affects spending, and rescaling the resulting magnitudes to account for the fact that not all patients continue to see their first PCP.

We use Difference in Differences regression to estimate the effects of a patient's physician's integration status on patient level spending. The unit of observation is an patient *i* at year *t*. We restrict this analysis to patients aged 25 to 64 for two reasons. First, pediatric patients and adults see different sets of physicians. Second, the ACA led to particularly large changes in coverage for the 18 to 25 age group during our sample period. While we include a control for expected medical expenditures by age and gender, excluding this age group creates a more consistent sample over time. We also eliminate all individuals who have not visited a PCP in past or the present year. Finally, to create as clean of a control group as possible, we eliminate all individuals whose first main PCP integrated before the beginning of our data.

Allowing Y to be a measure of enrollee spending (logged annual enrollee spending when spending is greater than zero and an indicator for zero spending), α_i to be an individual specific fixed effect, and $\alpha_{[m]t}$ to be a time fixed effect (in some specifications, we allow for different time trends by metropolitan area), X_{it} to be time varying individual specific controls (in particular, expected expenditures based on patient age and gender), VI_{it} to be the share of PCP E&M visits that are to a VI physician, we run regressions of the form:[15]

$$Y_{it} = \alpha_i + \alpha_{[m]t} + \gamma X_{it} + \beta VI_{it} + \varepsilon_{it} \tag{2}$$

where we instrument for VI_{it} as discussed above.

Overall Effect of VI on Total Health Spending

Unfortunately, it is both difficult and overly simplistic to assign patients to individual physicians. Patients often see many different physicians in a given year, including both primary care physicians and specialists; some patients even see multiple physicians within the same specialty. Thus, our method of assigning a patient to a single physician oversimplifies how integration can affect patient/physician interactions. Our

[15] We collect data on spending by age x gender from tables created by the Health Care Cost Institute. Source: http://www.healthcostinstitute.org/SOA-1-2013

second approach overcomes this problem by creating an instrument that measures the "exposure" of patients to integration, based on the locations (specifically, residence zip codes) of patients and the practice locations of integrating physicians. We correlate this instrument with changes in total health spending. The following example helps illustrate our method. Suppose that a physician group that largely serves zip code xxxxx is acquired by a hospital. Another physician group that largely serves zip code yyyyy remains independent. Thus, residents of zip code xxxxx face greater "exposure" to integration – they are increasingly more likely to be treated by integrated physicians. If acquisition affects spending, then we should observe different spending trends for patients in the two zip codes. The difference in the trends gives us the effects of exposure to integration. With this second IV approach, we do not have to assign patients to physicians.

We create the instrument as follows. We interact each physician's average market share from across the years of the data with whether the physician undergoes VI from year t to t-1.[16] We perform these calculations separately for primary care and specialist physicians and call the resulting differences $\Delta Share\ Primary\ Care\ VI$ and $\Delta Share\ Specialist\ Care\ VI$. At any given time, the sum of past changes in these prior changes in share serve as an instrument for the cumulative changes in VI in each zip code - we call the sum of these past shocks $\sum \Delta Share\ Primary\ Care\ VI$ and $\sum \Delta Share\ Specialist\ Care\ VI$.

We use Difference in Differences regression to estimate the effects of zip code level integration on zip code level spending. The unit of observation is a zip code (z) at

[16] The results are similar if we allow the physician shares to vary each year. i.e. if we use a physician's share of revenues in year t-1 rather than their average share.

year t. As in the analysis above, we restrict this analysis to patients aged 25 to 64. Allowing Y to be a measure of spending per enrollee (we use both mean and median spending per enrollee), α_z to be a zip code specific fixed effect, and $\alpha_{[m]t}$ to be a time fixed effect (in some specifications, we allow for different time trends by metropolitan area), X_{zt} to be time varying zip code level controls (in particular, expected expenditures based on patient age and gender, as well as a zip code level HHI), VI_{zt} to be the share of physician spending by Vertically Integrated providers in zip code z in year t (we separately measure the share of physician spending that is Vertically Integrated for primary care physicians and specialists, so VI_{zt} is a 2x1 matrix for each z, t), we run regressions of the form:

$$\ln(Y_{zt}) = \alpha_z + \alpha_{[m]t} + \gamma X_{zt} + \beta VI_{zt} + \varepsilon_{zt} \qquad (3)$$

where we instrument for VI_{zt} as discussed above.[17]

One of the states in our sample has data limitations, insofar as some providers received substantial and unusual quality and cost control incentives from one of the data providers, but these incentive payments are not recorded in our data. We exclude this state from the current draft, but will add it to future versions of the paper after obtaining richer data.

[17] Spending is highly skewed. We have confirmed that the results are similar if we windsorize spending at the top .1 percent or top .01 percent of spending relative to expected spending by age x sex.

IV. Results

Summary Statistics

A substantial and growing share of physician spending is by vertically integrated physicians. Figure 1 presents the share of physician spending that is vertically integrated in 2007 and 2013 for inpatient procedures, outpatient/office procedures, and combined.[18] The overall share of physician spending that is vertically integrated increases from 16.9 percent in 2007 to 26.5 percent in 2013. The level of vertical integration is higher for inpatient physician spending than outpatient, although the growth is similar.

Figure 2 examines heterogeneity in vertical integration across physician specialties. We aggregated physicians into five specialties. Primary care and surgery are the two largest specialties in the data, comprising 24 percent and 14 percent of resource utilization, respectively.[19] We separately report cardiology and anesthesia/diagnostic radiology, which comprise 4 percent and 6 percent of resource utilization respectively. The remaining 52 percent of resource utilization is grouped into an "other" category. Surgery and cardiology are the most rapidly integrating specialties, showing growth rates of 85 percent and 117 percent respectively. Vertical integration of a few large cardiology groups pushes these numbers up, but even without them, cardiologists appear to have integrated more rapidly than other specialties. The sharp increase in integration among cardiologists has been noted elsewhere and coincided with a change in Medicare

[18] Because our sample of metropolitan areas grows over time, the growth rate in Figures 1 and 2 is based on within metropolitan area variation. The intercept is determined by the revenue weighted average of the metropolitan area fixed effects.

[19] We measure resource utilization based on our Medicare price data. We aggregate General Practice, Family Practice, Internal Medicine and Pediatric Medicine to create our primary care specialty. We aggregate General Surgery, Orthopedic Surgery, Neurosurgery, Plastic Surgery, Hand Surgery, Thoracic Surgery, Colorectal Surgery, Cardiac Surgery, Vascular Surgery and Surgical Oncology to create our Surgery specialty.

reimbursement policy that made VI more attractive.[20] Anesthesiologists, diagnostic radiologists, and pathologists have been historically likely to either integrate with a hospital or to work in a practice with an exclusive relationship with a hospital. Consistent with this, we find high levels of integration in 2007, but see smaller increases in vertical integration for these specialties over time.

Table 1 presents summary statistics for the effects of VI by a patient's PCP on spending. We present statistics separately for individuals whose first PCP: (1) is already integrated when the patient joins our sample, (2) never integrates, (3) integrates during our study period. The average age and sex of enrollees is very similar across the three samples. The integration decision of an individual's first main PCP is very predictive of how likely the individual is to see a VI PCP for E&M visits. Individuals assigned to a first PCP who is always VI have average spending that is about 12 percent higher than individuals whose first PCP is never VI. This difference is larger (14 percent) for median spending. Spending of the individuals whose first PCP undergoes VI during our sample period is between those of the other samples.

Table 2 presents summary statistics for our zip code level analysis of the effect of VI on spending. Average monthly spending is $306 at the mean and $68 at the median, reflective of the skewed distribution of medical spending. Primary care physicians have higher levels of integration than specialists, but most of this is due to pre-existing differences from before our sample period, rather than more rapid increases in VI among these physicians. Most (76 percent) spending by physicians is by specialists rather than by primary care physicians.

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[20]See, for example: http://www.nationaljournal.com/magazine/heart-palpitations-over-medicare-20111208

The Effect of Vertical Integration on Prices

As a first check on whether physician pricing changes post integration, Figure 3 reports the coefficients on the on lags and leads relative to the date of integration. Prices of integrating physicians are rising faster than prices for non-integrating physicians even prior to integration, which may be a sign that these physicians are somewhat different or evidence that some integration occurs before we measure it. Starting in the year of integration, there is a clear break from trend with prices rising approximately 10 percent from the year before integration to the year after integration.

In Table 3, we present versions of the regression matching equation (1) in which post integration years are pooled into a single dummy Panel present results using *Price* as a dependent variable, Panel B present results using *OPPrice* as the dependent variable, and Panel C present results using *IPPrice* as the dependent variable. The first column for each dependent variable contains year x CBSA fixed effects, the second column contains year x CBSA x specialty fixed effects, the third column adds HHIs, and the fourth column adds in *UpcodeFF* and an interaction between *UpcodeFF* and VI.

Based on Column (2), our preferred overall specification for prices, we observe average increase in prices of 13.7 percent post integration.

Vertical mergers can affect pricing through their effects on horizontal market structure. To isolate the vertical effects, we control for horizontal physician market structure – measured by physician HHIs calculated using actual patient flows – in columns (3) of Table 3. Column (3) of Panel A suggests that overall prices are about 9.1 percent higher in monopoly markets than in perfectly competitive markets. Thus, we conclude that VI leads to higher physician prices, independent of any effects of physician concentration.

Another immediate question is whether this is being driven entirely by facility fees or whether prices have gone up more generally. Two pieces of evidence speak to this question. First, Column (4) adds in as a control ln(*UpcodeFF*), which can be thought of as the mark-up that Medicare would have paid on the bill because of facility fees. The interaction between ln(*UpcodeFF*) and VI tells us how much more responsive actual prices are to this mark-up for physicians who are hospital owned. Importantly, the coefficient on VI falls from about 0.12 to about 0.09, which suggests that facility fees account for approximately one quarter of the price increase. The coefficient on ln(*UpcodeFF*) of about 0.2 in Panel A suggests that private insurer reimbursements are much less responsive than Medicare to differences in place of service, even conditional on the insurers being willing to a pay a facility fee – if the insurers were increasing their reimbursements by one percent because of facility fees when Medicare increased its reimbursements by one percent because of facility fees, then this coefficient would be one. Intriguingly, the positive coefficient on the interaction between ln(*UpcodeFF*) and VI suggests VI physicians face reimbursement schemes with larger gaps between the facility fees and office reimbursements. Overall, our calculations suggest that for VI physicians, a dollar in Medicare upcoding potential from facility fees translates into roughly a dollar of reimbursements, but that this represents only a small portion of the overall price increase resulting from integration.

Panel C contains further suggestive, albeit less direct, evidence on the role of facility fees. Recall that in an inpatient setting, hospitals charge separate facility fees regardless of whether a physician is vertically integrated. When calculating inpatient prices, no facility fees are included in the numerator or the denominator. Therefore, the 6 percent increase in inpatient prices is not caused by facility fees. The effect of vertical integration on outpatient prices is approximately twice as large as the effect on inpatient prices. While hardly dispositive, this is a second piece of suggestive evidence that part, but not all, of the outpatient price increases is a result of facility fees. It also suggests that inpatient price increases from VI are lower than outpatient price increases from VI for reasons beyond facility fees.

In Table 4, we examine heterogeneity across specialties in the effects of vertical integration on prices. Panel A presents results for overall prices, Panel B presents results for outpatient/office prices and Panel C presents results for inpatient prices. Within each panel, column (1) present results for primary care, column (2) presents results for surgery, column (3) presents results for cardiology, column (4) presents results for anesthesia/diagnostic radiology and column (5) presents results for a residual category.

Beginning with primary care in column (1), we find smaller than average effects of vertical integration on pricing. Interestingly, the price effects are smaller for outpatient prices than for inpatient prices, opposite to the general pattern. It could be that private insurers are unwilling to pay facility fees for some procedures performed by PCPs, or that such procedures are a comparatively small portion of what PCPs do. Regarding the former, the largest component of primary care spending is Evaluation and Management (E&M) visits. Medpac (2012) argued that Medicare should equalize payments for E&M visits across different places of service. Under Medicare's current pricing rules, a 15 minute E&M visit results in payments that are 70 percent higher when billed on a hospital-based basis rather than an office setting. Based on an investigation of our data, as well as a discussion with our data provider, we determined that our insurer(s) do not reimburse for facility fees for E&M visits.

Columns (2) and (3) present results for surgery and cardiology respectively, two of the specialties that experienced faster rates of vertical integration. The price increases from vertical integration are above average for these groups. For example, cardiology prices increase nearly 34.3 percent post integration. These price increases are larger in the outpatient/office setting than in the inpatient setting, consistent with facility fees contributing to the higher prices. In column (4), anesthesia and diagnostic radiology experience a small and statistically insignificant price increase following vertical integration. Notably, anesthesiology and radiology are two primarily hospital-based specialties, meaning there is a strong complementarity between the demand for hospital services and the demand for these specialties' services. This complementarity may lead to a double marginalization problem under separate ownership, and therefore induce a single owner of both hospitals and the accompanying hospital-based specialists to lower prices. An important open question for future research is how much of the variation in price increases across different specialties is driven by facilities fees, referrals to more expensive care sites, changes in bargaining power, or other confounding differences among the types of groups being acquired or among the acquiring chains.[21]

In Table 5, we examine heterogeneity in the effects of vertical integration on prices, based on the characteristics of the acquiring hospital. In column (1), we include

[21] The "market power" theory for why prices increase from vertical integration suggest that super-additive pricing can result, under some circumstances, from consumer switching among insurance products in search of the most desirable networks (Dafny et al., 2014)..

an interaction between vertical integration and the acquiring hospital's inpatient share in the metropolitan area. We include separate controls to allow the effect of vertical integration to differ across MSAs. Therefore, we are looking at whether physician prices increase more within a market for physicians acquired by a large vs smaller hospital system. We find statistically and economically significant evidence that physician prices increase more when physicians are acquired by hospital systems with larger inpatient shares. A monopolist hospital would, on average, increase vertically integrated physician prices by 20 percentage points more than a hospital with zero market share.

In column (2), we examine whether the acquiring hospital's ownership status affects the magnitude of the price increase. We categorize hospital systems as either for profit, non-profit, or government using the 2010 American Hospital Association (AHA) data. We also include an unknown category for hospital tax IDs in our claims data that do not own any hospitals in the AHA sample. An inspection of the data suggests that most of these are inpatient facilities which are not general acute care hospitals. There is little evidence of heterogeneity in post-Vertical integration price increases based on ownership status.

In Column (3), we examine whether the acquiring hospital's service type affects the magnitude of the price increase. Again using the 2010 AHA data, we categorize systems as acute care, pediatric, specialty (i.e. cardiac or orthopedic surgery) or psych/long-term care/other. Again, we create an unknown category. Price increases are entirely driven by acute care hospitals and by the unknown category.

Approximately 40 hospital systems are responsible for the vast majority of VI in our data. To further explore heterogeneity in our price results by acquirer characteristics, we reran our main pricing equation, but included chain specific fixed effects for all hospital systems ever owning 100+ physicians. Figure 4 is a scatter plot of the number of physicians owned by each chain in 2013 compared with their chains estimated price increase from VI. Figure 5 is a scatter plot of the number of physicians acquired from 2010 to 2013 by each chain (the years in common across all our states) and the price increases.

The Effects of Vertical Integration on Spending: PCP Analysis

We begin by examining what happens to total spending for patients whose PCPs are acquired. Table 6 provides visual evidence of our main results. We first demonstrate that when a patient's PCP integrates, that patient receives substantially more care from a VI PCP (i.e., the patient does not immediately switch to a non-VI PCP) as compared to patients in the control group. The figure in the first row and first column presents the first stage relationship between the share of an individual's PCP E&M visits that are to VI providers and the VI status of the individual's first main PCP. VI of the individual's first main PCP leads to an immediate increase of approximately 70 percent in the share of PCP E&M visits that are VI.

Turning to spending, the figure in the first row, second column shows the growth in health spending by patients of VI PCPs from four years prior through four years after integration, when compared with patients of PCPs in the control group. There is a steady increase in spending, conditional upon having positive spending, that begins well before integration. This trend reverses after integration. At first blush, this suggests that PCP integration leads to lower spending; we will examine this finding in more detail below.

Row 1, column 3 examines whether integration of an enrollee's first main PCP affects the probability of having positive spending. There is little definitive pattern here and the magnitudes are small.

We further investigate the mechanism through which VI affects spending trends by splitting the sample. The first subsample, which contains 31 percent of patient years, consists only of those patients who continue to see their first main PCP in each year in the data. The second subsample consists of the remaining 69 percent of patient years; i.e., those patients who either do not have a PCP E&M visit in some year or who switch their main PCP over time. We then rerun our spending analysis on each subsample. The second row of results in Figure 6 contains results for the first subsample; the third row contains results for the second subsample.

The dramatic increase in VI Share of PCP Visits depicted in the first figure in the second row reflects the tautological relationship between the first main PCP's VI status and the share of visits to a VI PCP, for those patients who have kept their first main PCP. Turning to spending, the second figure in row 2 shows that spending is relatively flat until two years prior to VI, compared with the patients in the control group for this subsample.[22] There is a small increase in spending in the year prior to VI, followed by larger increases concurrent with and after VI. There are at least two different explanations for these patterns. First, it could be that patients who stick with the same PCP are more likely to suffer negative health shocks that happen to coincide with the timing of integration. Alternatively, it could simply be that VI leads to higher spending.

[22] Because the sample in row 2 is restricted to patients with an E&M visit with their first PCP in the year, all patients have positive spending each year, so we do not report a third figure in this row.

Row 3 presents results for those patients who switch main PCPs at any point. Recall that patients who keep their first "main" PCP in all years and have that PCP integrate end up having nearly 100 percent of their visits to VI PCPs after their first main PCP integrates. Patients who switch from their first main PCP have a different experience. If their first main PCP integrates but they switch to another PCP, then only about 50 percent of their visits, in the years after their first main PCP integrates, will be to a VI PCP. (Both percentages are relative to those for their respective control groups.) Moreover, spending for these patients appears to increase prior to VI by their first main PCP, and then decrease afterwards.

Taken together, these findings suggest VI by a patient's first "main" PCP could lower spending not because of better clinical management by the PCP, but *because some patients switch to less expensive PCPs*. To investigate this hypothesis, we rerun the spending regression but allow for the effect of first main PCP integration to vary according to the time between when that PCP integrates and when the patient stopped seeing that PCP.[23] We focus on only the main specification, which uses as logged spending as the dependent variable. Furthermore, because of the large number of relevant coefficients, we omit standard errors. Results are presented in Figure 7. The figure in the first row and first column plots results for patients who last see their first "main" PCP between 1 and 4 years prior to that PCP becoming VI. There is a decline in spending just after this period – i.e., from year -1 to year 0. By this time, the patient has

[23] We provide two clarifying examples. First, suppose that in all years subsequent to being assigned to a first main PCP, an enrollee continues to have E&M visits with this PCP, but has more E&M visits with another PCP. In this case, the patient would be coded as stopping having the first main PCP as a main PCP after the first year. A second example, suppose that until 4 years after a patient's first main PCP is VI, the patient only visits other PCPs, but reverts to seeing the first main PCP 4 years post VI. In this case, the patient would be coded as stopping having the first main PCP as a main PCP four years post integration.

selected a new main PCP so it is unlikely that the spending decline is causally related to VI by the first "main" PCP. Indeed, across the 6 panels of Figure 7, there is consistent evidence that the decline in spending that we observe when a patient's first "main" PCP becomes VI occurs in the year after the last year that PCP is the patient's "main" PCP. We are hard pressed to attribute this decrease to VI by the original PCP. Instead, it appears that patients are simply switching to lower cost PCPs.[24] Conversations with our data provider suggest this is possible in light of trends towards more restrictive network structures (i.e. certain high cost systems being excluded from narrower networks) and higher patient cost sharing.

Overall, these results provide no evidence that PCP VI leads to lower spending because of improvements from clinical integration. Instead the evidence is consistent with PCP VI leading to higher costs for those patients who keep their PCP, and lower costs for those patients who switch to other PCPs.

How large of a spending increase might be attributable to integration by PCPs? Table 6 presents a pooled version of the results, restricting the sample to only those enrollees who continue to see the same "main" PCP each year after they first see that PCP. Column (1) looks at the endogenous relationship between the share of E&M visits that are to a VI PCPs and spending. This regression is presented for completeness, but as the selected nature of the sample ensures that patients are largely seeing the same PCP in each year, we do not suggest any interpretation of the result. Column (2) confirms that

[24] Even among the patients who have already changed their "main" PCP, VI by their first "main" PCP still leads to increases in the share of PCP E&M visits for that patient that are to VI PCPs. One possible explanation is that some of these patients may be seeing multiple PCPs (including the first "main" PCP). Another is that these patients may be seeing another PCP in the same practice who therefore had a similar change in VI status. Understanding these dynamics is interesting, but beyond the scope of the current paper.

when an enrollee's first main PCP becomes VI that the enrollee has a higher share of PCP visits with VI PCPs. In column (3), an enrollee's first main PCP becoming VI leads to spending that is approximately 2.5 percent higher. The result is suggestive, but not statistically significant at conventional levels. Column (4) presents the IV results, which suggest that VI leads to a (statistically significant) spending that is approximately 3 percent higher. Overall, the results suggest that if anything, VI by PCPs leads to higher spending, although the results are far from dispositive.

Effects of Vertical Integration on Spending: Exposure to Integration Analysis

As previously discussed, it can be difficult to assign patients to physicians. Thus, we complement the previous analysis by examining how "exposure" to VI affects spending. The analysis has two endogenous variables – $Share\ Primary\ Care\ VI$ and $Share\ Specialist\ Care\ VI$ and two instruments. Figure 8 presents the relevant first stage regressions for the instruments. Both first stages are run from the same specification, which includes lags and leads of all three instruments, as well as all of the controls in equation (3). Given the large number of parameter estimates in these models, we present only the key ones. Figure 8A presents the effect of $\Delta Share\ Primary\ Care\ VI$ on the share of PCPs that are VI. Next, Figure 8B presents the effect of $\Delta Share\ Specialist\ Care\ VI$ on the share of specialists that are VI. Overall, the first stage results confirm that when the physicians who serve an area become VI, that the share of patient care provided by VI physicians increases.

Figure 9 examines how VI affects spending and has four rows. We separately examine the effect of $\Delta Share\ Primary\ Care\ VI$ (presented in row 1), and $\Delta Share\ Specialist\ Care\ VI$ (presented in rows) on spending. Column (1) presents results from regressions that use logged mean spending as the dependent variable, whereas column (2) presents results from regressions that use logged median spending as the dependent variable.[25] For example, column (1), row (1) examines how lags and leads of $\Delta Share\ Primary\ Care\ VI$ affect logged mean zip code level spending.

Given the large number of estimates presented, we discuss only the most important findings. The evidence is neither clear nor consistent. The figures in the first row a show an ongoing decline in both mean and median spending that precedes PCP VI by as much as four years and continues for as much as four years after VI. The figures in the second rows show a similar long term trends for specialist VI, but in this case there is an ongoing increase in spending. In future analyses, we will further investigate what is driving these differences.

Estimates in Table 7 pool the post period years on spending for all physicians (i.e., PCPs and specialists). Columns (1) and (2) present results for mean spending, whereas columns (3) and (4) present results for median spending. Beginning with column (1) we present results looking at the relationship between the actual share of care provided by VI PCPs and mean spending per capita in the sample with incentives to providers. We find that a market with all VI PCPs would have medical spending that is a (statistically insignificant) 1.6 percent lower. In column (2), we instrument for the share of PCPs who are VI and find that in markets with all VI PCPs, spending would have been a (statistically insignificant) 2.2 percent lower. Columns (3) and (4) uncover statistically significant decreases in median spending when PCPs become VI, although as already noted given the pre-trends, there is no reason to interpret these results causally. Finally,

[25] Some zipcode x year cells have no spending and are therefore dropped from this analysis. These cells represent less than .0001 percent of enrollee months, so in the interests of brevity are ignored.

note that the zip code level results on the effects of PCP VI are sufficiently noisy that they are not inconsistent with the results in the prior section (which are anyway constructed using just a subset of patients and physicians) which suggest that if anything PCP VI increases total spending.

Turning to the results for the share of specialists who are VI, in columns (2), a market with all VI specialists has mean spending that is a (statistically insignificant) 10 percent higher than a market with no VI specialists. In column (4), a market with all VI specialists has median spending that is a (statistically significant) 40 percent higher than a market with no VI specialists. As median spending is about 1/5th of mean spending, this is similar to an increase at the median of about 8 percent of mean spending. As the largest jumps in spending occur the year prior to specialist VI, it is far from clear whether one should interpret these results causally.

Table 8 decomposes the spending results into for a number of different spending categories (using BETOS codes to categorize spending other than inpatient).[26] These results provide little evidence for any of the theories of how VI might affect spending.

Conclusion

This paper examines the effects of the acquisition of physician practices by hospitals. We find that from 2007-2013 there has been a substantial amount of VI, with the share of spending by physicians whose practices are owned by hospitals increasing by approximately ten percentage points or more fifty percent.

[26]Berenson-Eggers Type of Service (BETOS) codes are an encyclopedic, hierarchical categorization of the HCPCS and CPT codes. We only break spending into the coarsest BETOS categories.

These acquisitions lead to substantial price increases for the acquired physician groups, with average price increases of nearly fourteen percent. These price increases vary substantially across specialties, with PCP prices increasing by approximately twelve percent and prices for cardiologists increasing by approximately thirty four percent. Our calculations suggest that aggregate physician prices were approximately one and a thrid percent higher in 2013 than they would have been had hospital ownership of physician groups remained at its 2007 level.[27] These price increases do not appear to be explained by "traditional" increases in horizontal market power within physician markets. However, these price increases are larger for hospital systems that are more dominant within their market – we estimate that physician prices would increase over 20 percent more when acquired by a monopolist hospital system than by a hospital system in a perfectly competitive market. Finally, we estimate that approximately one quarter of the price increases are due to increased exploitation of reimbursement rules that allow hospitals to charge "facility fees" for services by hospital owned physicians.

We also examined how these acquisitions affected total spending. Here, the evidence was less conclusive. Integration of primary care physicians seems to have little effect on spending, although our preferred analysis suggests PCP VI leads, if anything, to higher spending. There is no evidence that VI by specialists leads to lower spending. Again, if anything, spending is higher after specialist VI than before, although it is difficult to determine whether these results are merely a continuation of trend. Finally, we note that most of the results on expenditures are not sufficiently precise for us to distinguish between three hypotheses: (1) VI increases prices but decreases utilization

[27] This follows from the fact that the share of physicians who are VI increased by 9.7 percentage points and that VI increases prices by 13.7 percent price.

sufficiently to offset the price increases (2) VI increases prices and has no effect on utilization (3) VI increases prices and leads to moderate increases in utilizations. Physician price increases are a small enough share of spending that it is difficult to detect the effect of the price increases that we uncover on overall spending.

This paper raises a number of important questions for future work. First, future work should further examine how VI affects the expenditures of specialty care at a more granular level, such as by studying episode level spending. Second, future work should examine the effects VI on measures of quality, such as hospitalizations due to potentially avoidable complications. Third, future work should dig deeper into the reasons for the variation in price increases from vertical integration across acquisitions. Relatedly, future work should perform a more detailed analysis of how much market power physician groups have, and how much the market power of physician groups increases as a result of mergers.

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Figure 1: Share of Physician Spending Vertically Integrated, 2007 vs 2013

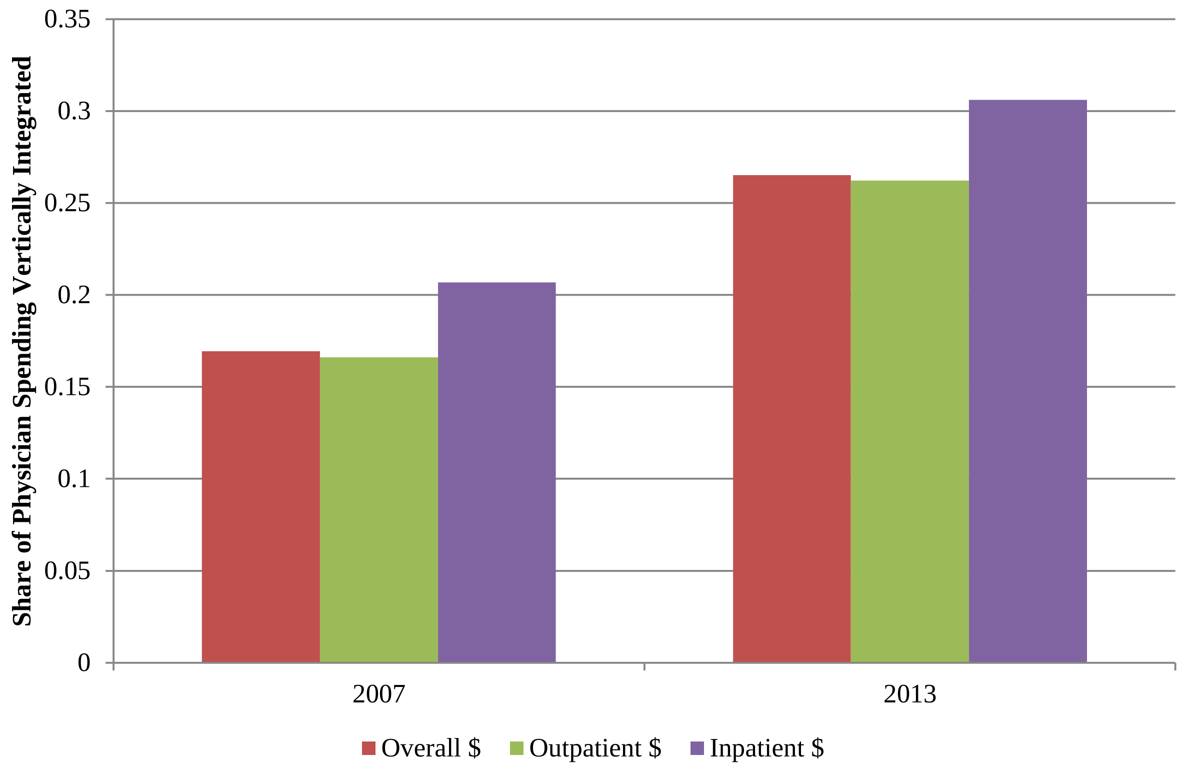
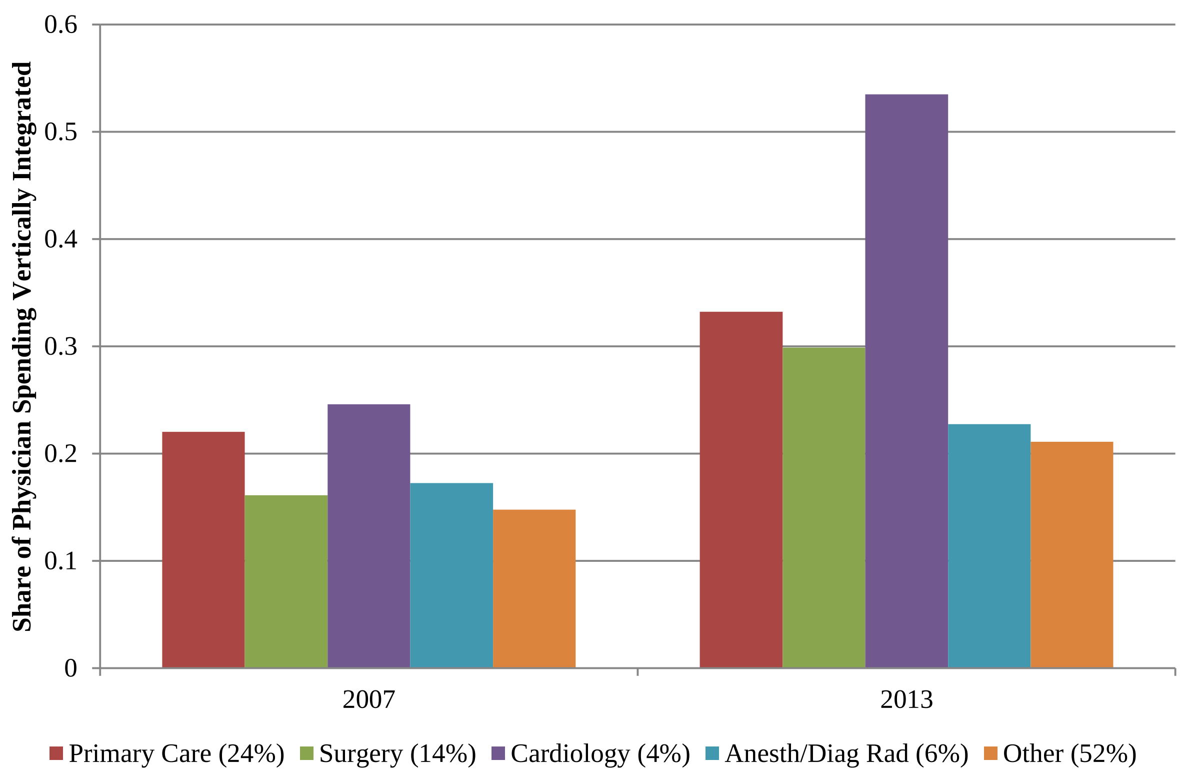
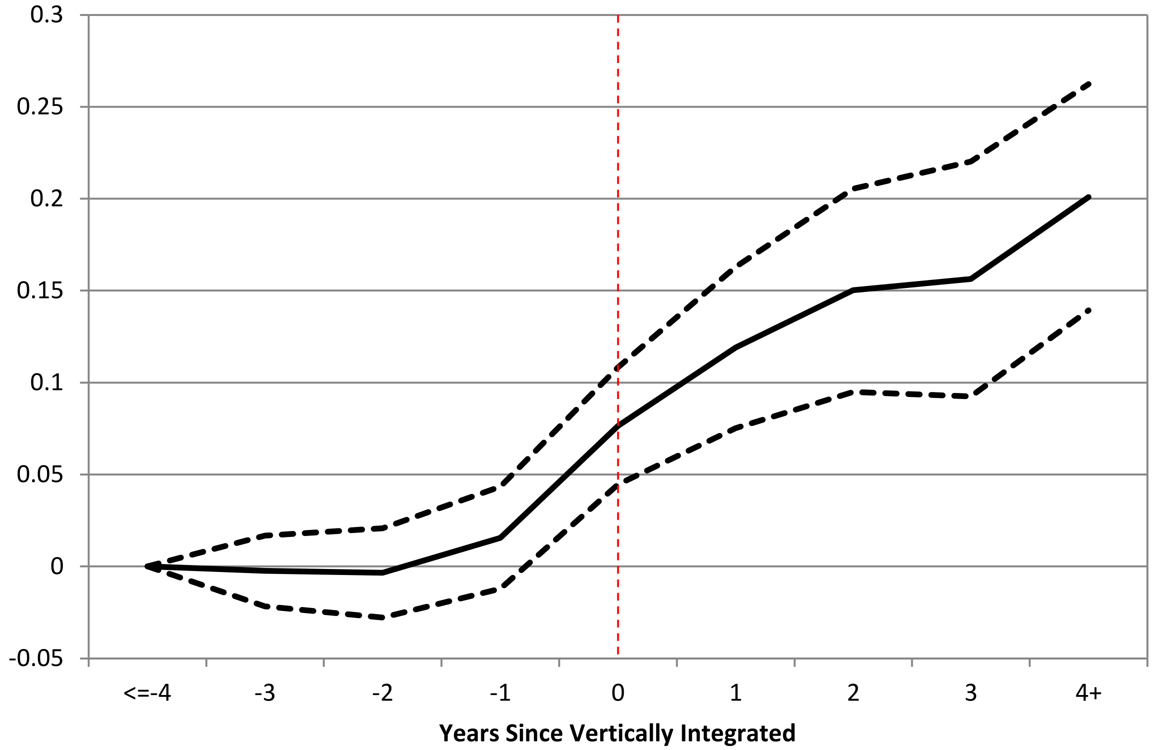


Figure 2: Share of Physician Spending Vertically Integrated, 2007 vs 2013 (By Specialty)



Notes: Numbers in parentheses by specialty labels are the share of physician spending attributable to each specialty.

Figure 3: Effect of Vertical Integration on ln(Price)



Notes: Regressions contain physician and year x CBSA x specialty fixed effects, as well as a physician specific HHI. Unit of observation is the physician x year. Regressions are weighted by Medicare PFS allowed. Dashed lines represent 95% confidence based upon standard errors clustered by the cartesian product of a physician's main tax ID in each year and the physician's specialty.

Figure 4: Avg Price increase for Integrating Physicians by Number of NPIs in Purchasing system in 2013

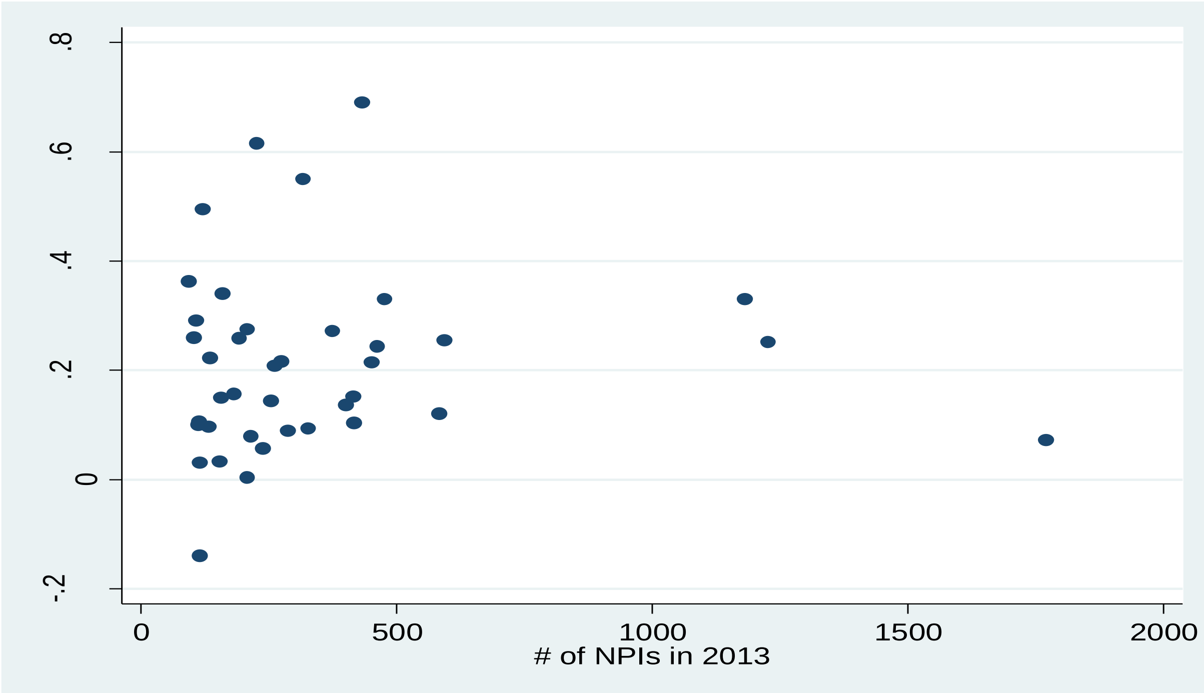
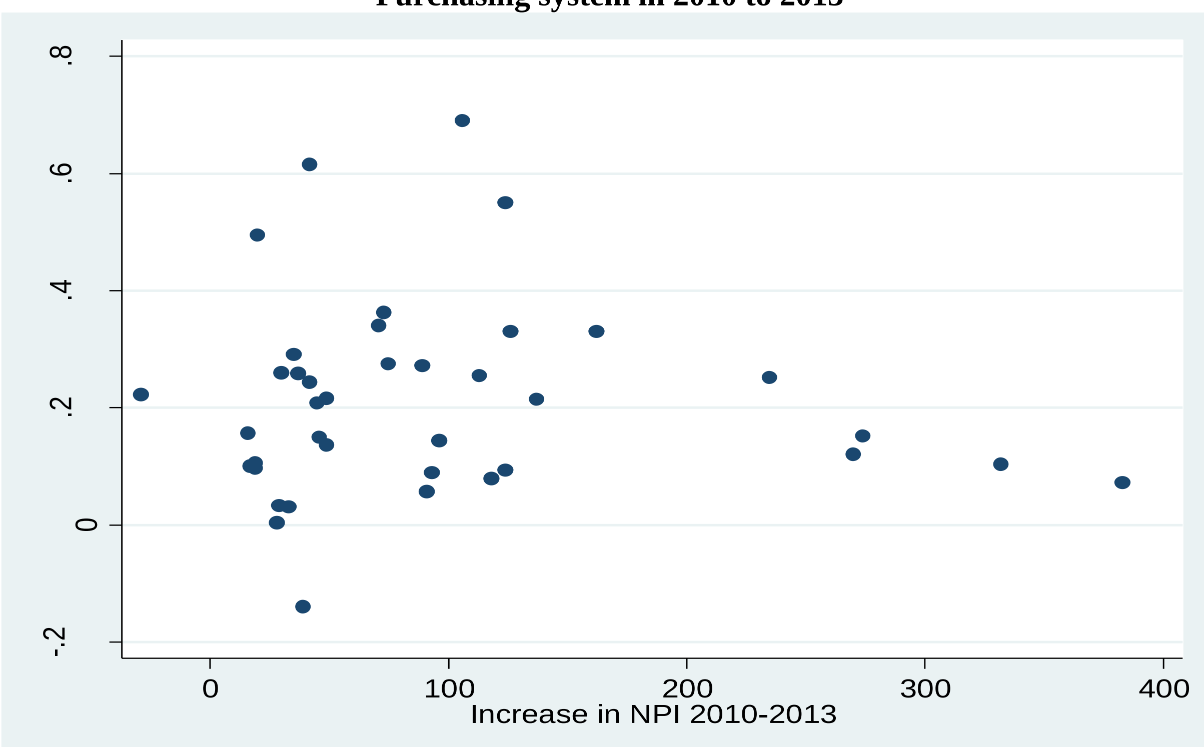


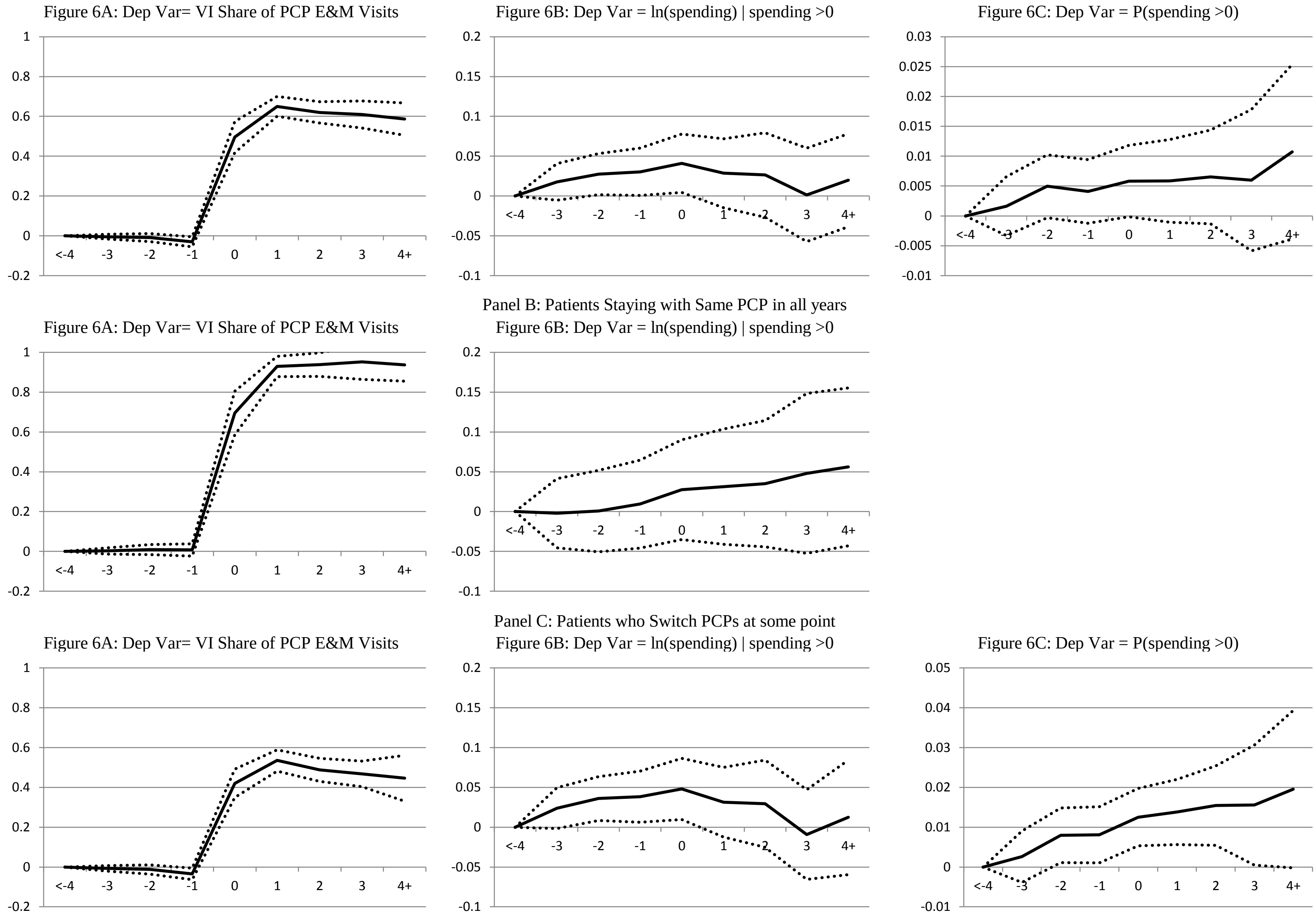
Figure 5: Avg Price increase for Integrating Physicians by Change in Number of NPIs in Purchasing system in 2010 to 2013



Notes: Each observation represents one of the chains that at some point has 100+ NPIs in our data.

Figure 6: Effect of 1st main PCP VI on Spending

Panel A: Full Sample

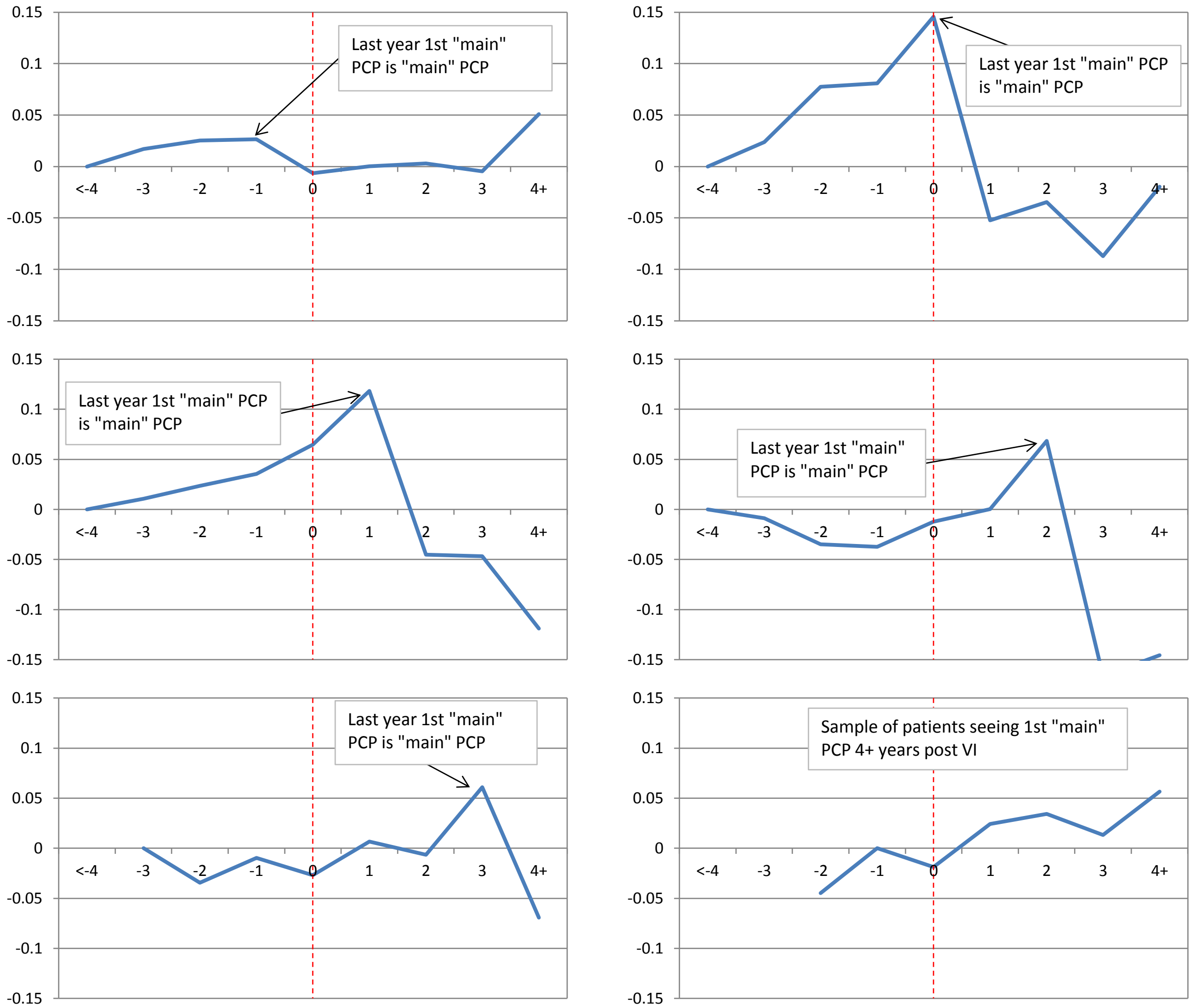


Notes: Unit of observation is the enrollee year for enrollees who have had a PCP visit in the current year or prior years and whose "main" PCP in the first year they are in the data was not VI. Regression contains enrollee and CBSA x year fixed effects. Dashed lines represent 95% confidence based upon standard errors clustered by the cartesian product of each enrollee's first main PCP's main tax ID in each year and the physician's specialty.

Figure 7: Effect of 1st main PCP VI on Spending

(Heterogeneity Based on Last year enrollee sees 1st "main" PCP)

Dep Var = ln(spending) | spending >0



Notes: Lines represent lead and lag coefficients for the effect of an enrollee's first main PCP becoming VI on spending. Unit of observation is the enrollee year for enrollees who have had a PCP visit in the current year or prior years and whose "main" PCP in the first year they are in the data was not VI. Regression contains enrollee and CBSA x year fixed effects.

Figure 8: First stage regressions

Figure 8A: Dep Var = Share of Primary Care VI

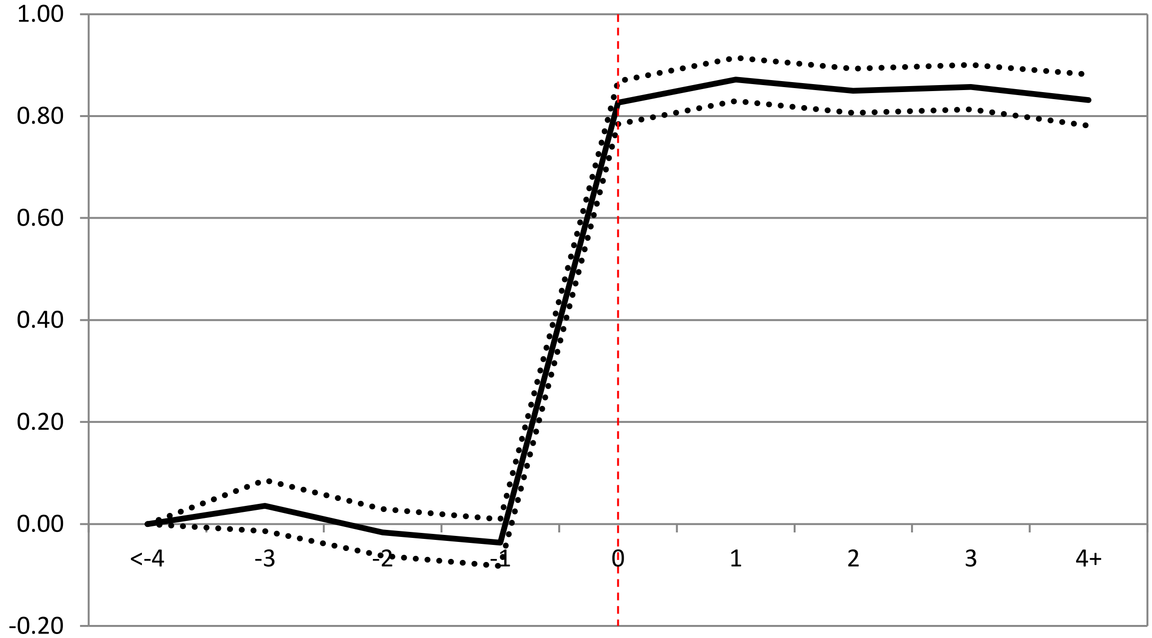
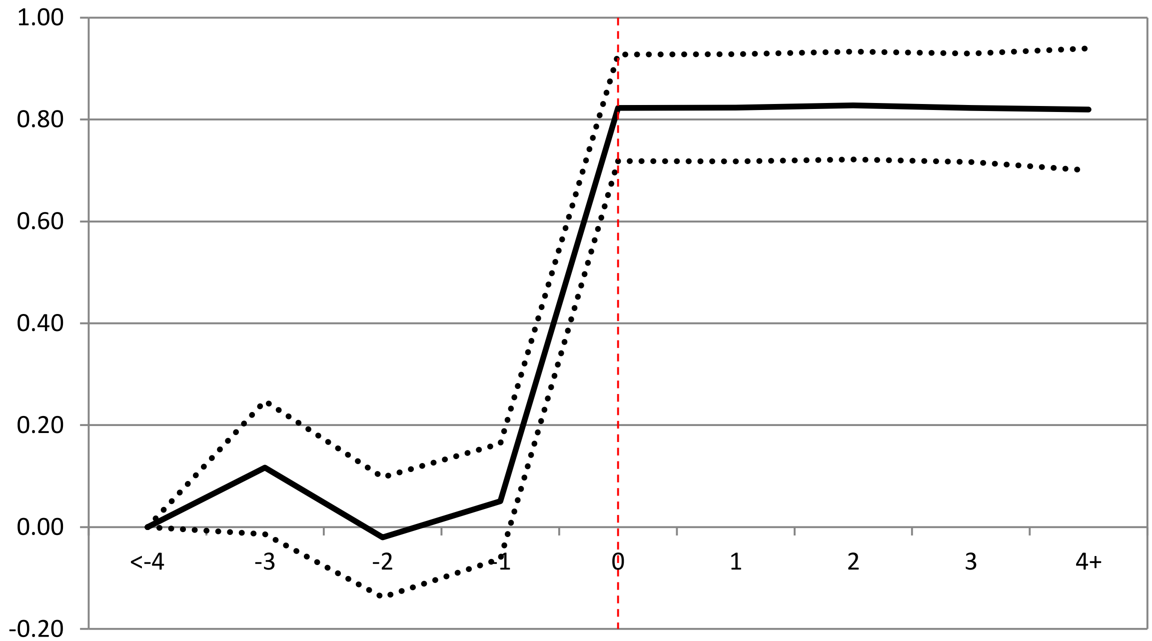


Figure 8B: Dep Var = Share of Specialty Care VI

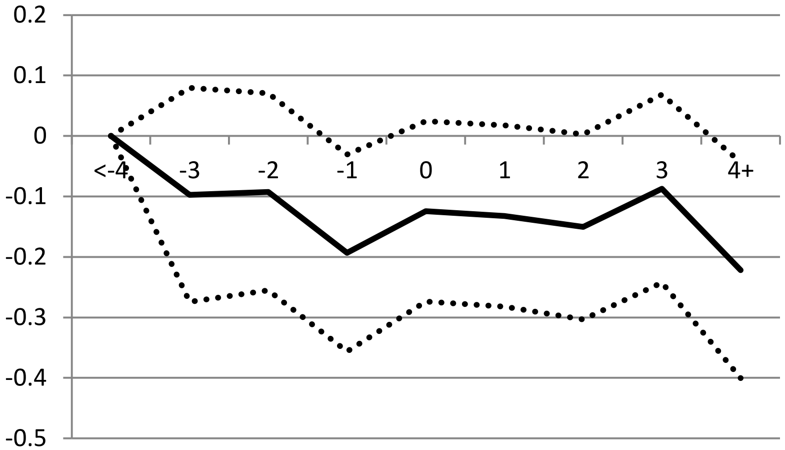


Notes: Unit of observation is the zip code x year. Figures present the key instrument for regressions using as a dependent variable each of the three endogenous variables. All regressions were run using the same set of independent variables: lags and leads of dHHI, lags and leads of dShare of Specialty Care VI, lags and leads of dShare of Primary Care VI, zip code fixed effects, cbsa x year fixed effects, and HCCI's estimated average spending for the sample based on age and gender. Regressions are weighted by enrollee months. Point estimates and upper and lower bounds of 95% confidence interval are reported.

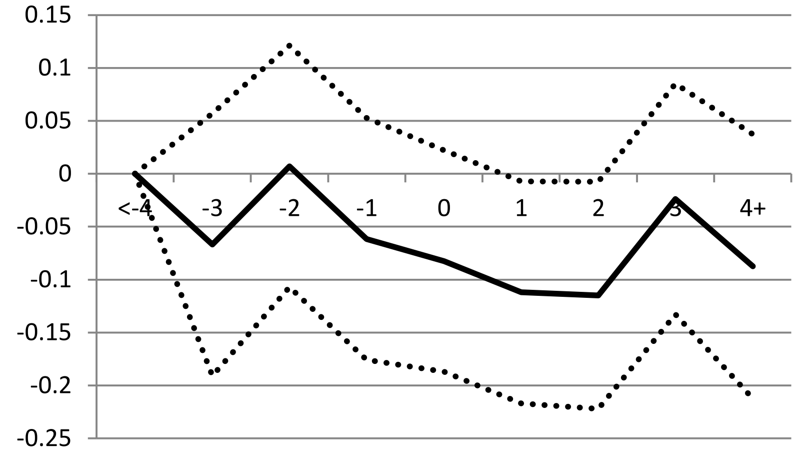
Figure 9: Reduced Form Regressions

Indep Var = ΔShare of Primary Care VI

Dep Var = ln(Mean Spending)

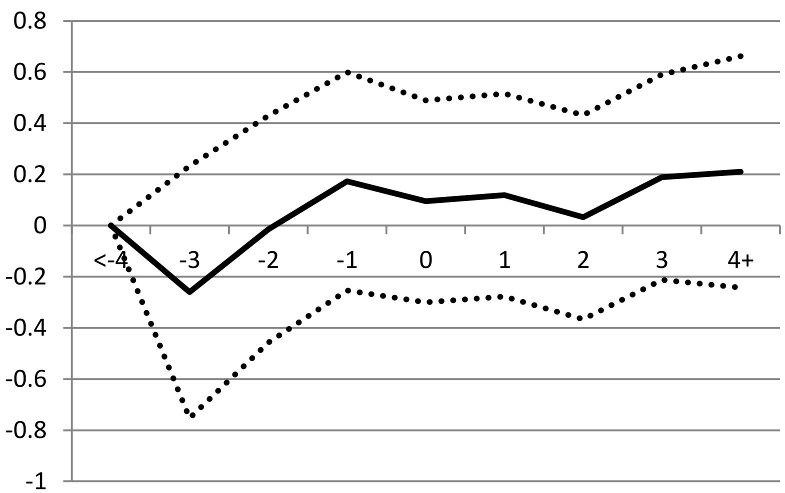


Dep Var = ln(Median Spending)



Indep Var = ΔShare of Specialist Care VI

Dep Var = ln(Mean Spending)



Dep Var = ln(Median Spending)

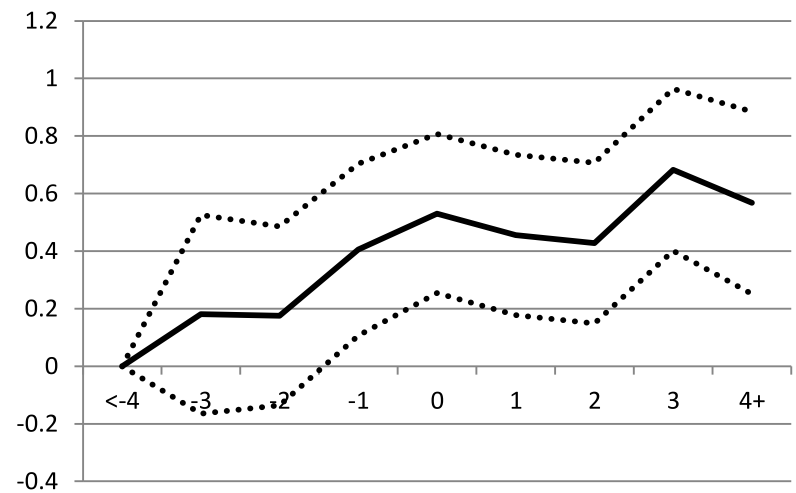


Figure 10: Average Price Increases from VI for all physicians of large systems vs Average Cost Increases for PCPs of the same large systems

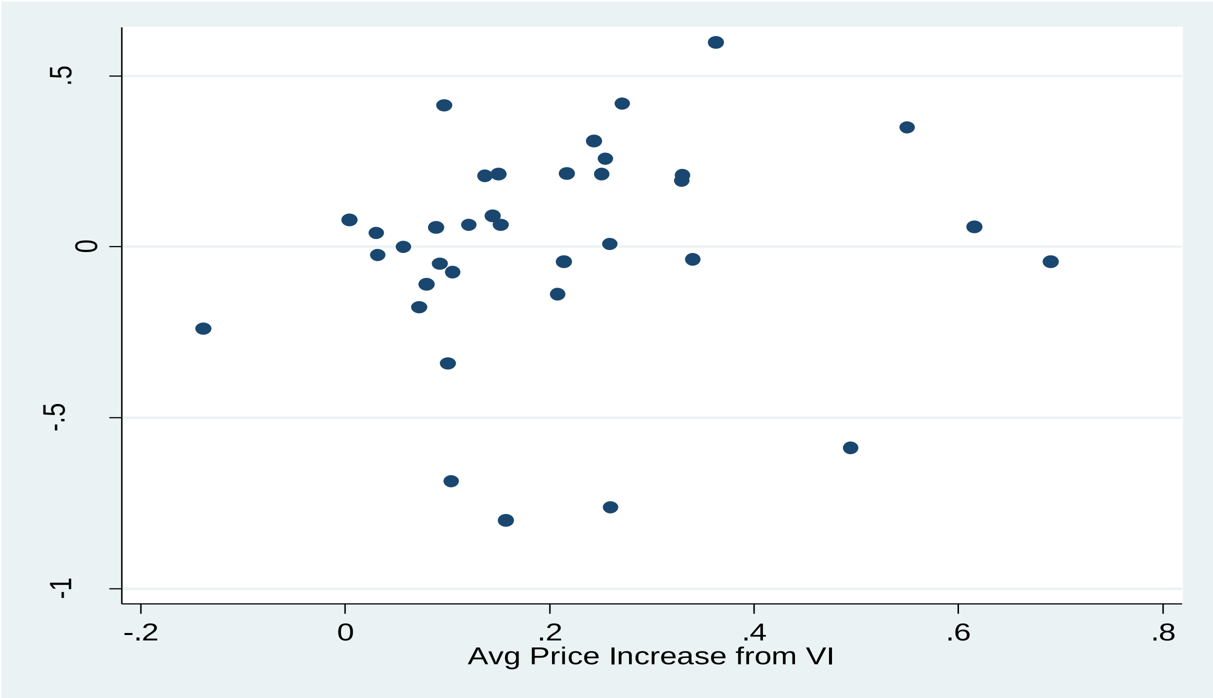
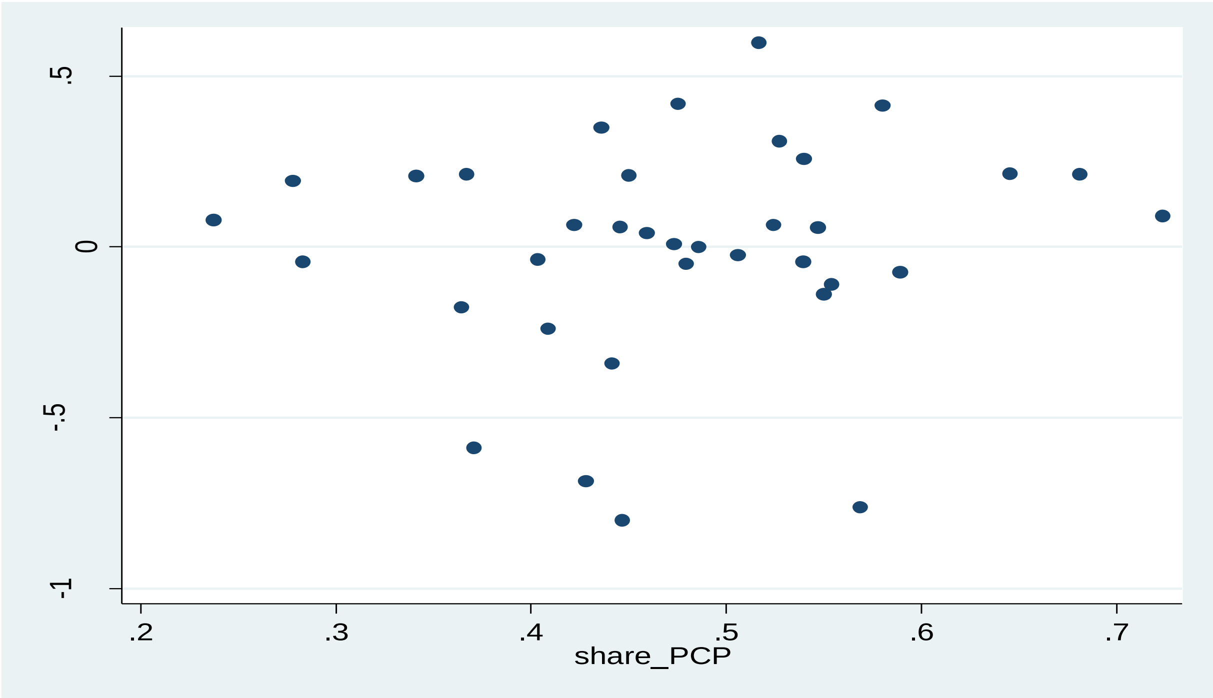


Figure 11: Average Price Increases from VI for all physicians of large systems vs share of owned Physicians that are PCPs



Notes: The Y variable in Figures 10 and 11 is the average cost increase by organization recovered from a regression like in Table 6, column (3), but rerun with chain level fixed effects for all chains ever having 100+ NPIs. We compare these with the average price increases by organization from VI and with the share of an organization's VI physicians which are PCPs.

Table 1: Patient Level Summary Statistics

	N	Mean	Median	Std Dev	Min	Max
First PCP is Never VI						
Age	4,395,785	45.38	46.00	9.65	26.00	63.00
Female	4,395,785	0.57	1.00	0.50	0.00	1.00
Age x sex Risk Score	4,395,785	1.27	1.22	0.42	0.40	2.34
Share of PCP visits that are VI	3,411,220	0.03	0.00	0.15	0.00	1.00
Average monthly spending	4,395,785	360	90	1,470	0	629,224
Has some spending in year	4,395,785	0.93	1.00	0.26	0.00	1.00
First PCP is Always VI						
Age	1,354,581	45.28	46.00	9.80	26.00	63.00
Female	1,354,581	0.57	1.00	0.49	0.00	1.00
Age x sex Risk Score	1,354,581	1.27	1.21	0.43	0.40	2.34
Share of PCP visits that are VI	1,075,570	0.93	1.00	0.24	0.00	1.00
Average monthly spending	1,354,581	404	103	1,579	0	324,159
Has some spending in year	1,354,581	0.94	1.00	0.24	0.00	1.00
First PCP undergoes VI						
Age	704,158	46.18	47.00	9.60	26.00	63.00
Female	704,158	0.57	1.00	0.49	0.00	1.00
Age x sex Risk Score	704,158	1.30	1.24	0.43	0.40	2.34
Share of PCP visits that are VI	504,656	0.36	0.00	0.47	0.00	1.00
Average monthly spending	704,158	385	94	1,640	0	488,028
Has some spending in year	704,158	0.92	1.00	0.27	0.00	1.00

Notes: Unit of observation is the patient x year. Sample is patients aged 25 x 64 with a PCP visit in the past or current year.

Table 2: Zip Code Summary Statistics

	N	Mean	Std Dev	Min	Max
Avg Spending per enrollee x month					
Mean	13,728	306	68	0	6,923
Median	13,728	65	17	0	4,827
Mean = 0	13,728	0.000000	0.000506	0.000000	1.000000
Median = 0	13,728	0.000014	0.003739	0.000000	1.000000
Share of Spending, by Category					
Durable Medical Equipment	13,725	0.02	0.01	0.00	0.58
Evaluation and Management	13,725	0.17	0.03	0.00	1.00
Other	13,725	0.13	0.05	0.00	0.84
Imaging	13,725	0.13	0.02	0.00	0.96
Procedures	13,725	0.24	0.04	0.00	0.90
Tests	13,725	0.08	0.01	0.00	0.74
Inpatient Facility	13,725	0.23	0.06	0.00	0.93
Specialist Share of Physician Spend	13,710	0.76	0.06	0.00	1.00
Consolidation Measures					
Share Primary Care VI	13,634	0.24	0.20	0.00	1.00
Share Specialist Care VI	13,625	0.14	0.12	0.00	1.00
HHI	13,728	0.32	0.09	0.05	1.00
$\Sigma\Delta$ Share Primary Care VI	13,728	0.11	0.37	0.00	2.49
$\Sigma\Delta$ Share Specialist Care VI	13,728	0.05	0.09	0.00	2.08
$\Sigma\Delta$HHI	13,728	0.00	0.01	-0.11	0.13
Percentiles of Enrollee months per zip code x year					
25th percentile	556				
50th percentile	3,925				
75th percentile	12,148				
Number of zip codes	2,272				

Notes: Unit of observation is the zip code x year. Sample is patients aged 25 x 64. Observations are weighted by the number of enrollee months in each zip code x year.

Table 3: Effect of Vertical Integration on Physician Prices

Panel A: Dep Var = ln(Price)				
	(1)	(2)	(3)	(4)
Vertical Integration	0.148	0.128	0.126	0.0918
	*[0.0208]****	*[0.0206]****	*[0.0205]****	*[0.0145]****
Physician Specific HHI			0.0873	0.0895
			*[0.0237]****	*[0.0218]****
ln(UpcodeFF)				0.211
				*[0.0101]****
(Vertical Integration)*ln(UpcodeFF)				0.267
				*[0.0343]****
Year x CBSA FEs	x	x	x	x
Year x CBSA x Specialty FEs		x	x	x
R-sq	0.913	0.92	0.92	0.929
N	250,105	250,105	250,105	249,026

Panel B: Dep Var = ln(OPPrice)				
	(1)	(2)	(3)	(4)
Vertical Integration	0.16	0.136	0.134	0.102
	*[0.0224]****	*[0.0222]****	*[0.0222]****	*[0.0157]****
Physician Specific HHI			0.0766	0.0798
			*[0.0246]****	*[0.0227]****
ln(UpcodeFF)				0.203
				*[0.00970]****
(Vertical Integration)*ln(UpcodeFF)				0.283
				*[0.0356]****
Year x CBSA FEs	x	x	x	x
Year x CBSA x Specialty FEs		x	x	x
R-sq	0.901	0.91	0.91	0.92
N	245,208	245,208	245,208	244,129

Panel C: Dep Var = ln(IPPrice)				
	(1)	(2)	(3)	(4)
Vertical Integration	0.068	0.0586	0.0558	0.0545
	*[0.0160]****	*[0.0149]****	*[0.0149]****	*[0.0157]****
Physician Specific HHI			0.174	0.173
			*[0.0323]****	*[0.0323]****
ln(UpcodeFF)				0.0229
				*[0.00956]***
(Vertical Integration)*ln(UpcodeFF)				0.00269
				[0.0246]
Year x CBSA FEs	x	x	x	x
Year x CBSA x Specialty FEs		x	x	x
R-sq	0.98	0.982	0.982	0.982
N	120,814	120,814	120,814	120,562

Notes: Unit of observation is the physician x year. We exclude the transition year from non-VI to VI. Regressions are weighted by Medicare PFS allowed. Standard errors in bracket are clustered by the cartesian product of a physician's main tax ID in each year and the physician's specialty. * p<0.10, ** p<0.05, *** p<0.01

Table 4: Effect of Vertical Integration on Physician Prices
(By Physician Specialty)

Panel A: Dep Var = ln(Price)

Specialty (% of Phys Spend)	Primary Care (24%)	Surgery (14%)	Cardiology (4%)	Anesth/Diag Rad (6%)	Other (52%)
	(1)	(2)	(3)	(4)	(5)
Vertical Integration	0.1110	0.0900	0.2950	0.0390	0.1290
	*[0.0226]******	*[0.0476]**	*[0.0364]******	*[0.0708]*	*[0.0270]******
R-sq	0.895	0.926	0.792	0.868	0.903
N	75,808	27,286	8,481	14,111	124,419

Panel B: Dep Var = ln(OPPrice)

Specialty (% of Phys Spend)	Primary Care (24%)	Surgery (14%)	Cardiology (4%)	Anesth/Diag Rad (6%)	Other (52%)
	(1)	(2)	(3)	(4)	(5)
Vertical Integration	0.1090	0.1110	0.3100	0.0413	0.1480
	*[0.0232]******	*[0.0547]****	*[0.0387]******	*[0.0717]*	*[0.0303]******
R-sq	0.892	0.849	0.800	0.868	0.901
N	73,643	26,592	8,437	13,803	122,733

Panel C: Dep Var = ln(IPPrice)

Specialty (% of Phys Spend)	Primary Care (24%)	Surgery (14%)	Cardiology (4%)	Anesth/Diag Rad (6%)	Other (52%)
	(1)	(2)	(3)	(4)	(5)
Vertical Integration	0.1	0.0588	0.128	-0.0258	0.0329
	*[0.0176]******	*[0.0292]****	*[0.0197]******	*[0.0769]*	*[0.0200]**
R-sq	0.931	0.992	0.86	0.888	0.865
N	35,911	19,654	7,590	8,886	48,773

Notes: Unit of observation is the physician x year. We exclude the transition year from non-VI to VI. Regressions are weighted by Medicare PFS allowed. Standard errors in bracket are clustered by the cartesian product of a physician's main tax ID in each year and the physician's specialty.
* p<0.10, ** p<0.05, *** p<0.01

Table 5: Effect of Vertical Integration on Physician Prices (By Acquirer's Characteristics)

	Dep Var = ln(Price)		
	(1)	(2)	(3)
By Inpatient Market Share			
VI*Acquirer's share	0.187		
	*[0.0778]***		
By Ownership Type			
For-Profit		0.128	
		*[0.0219]****	
Non-Profit		0.152	
		*[0.0290]****	
Government		0.148	
		*[0.0669]***	
Unknown		0.17	
		*[0.0523]****	
By Service Type			
Acute			0.15
			*[0.00923]****
Specialty			-0.0422
			[0.0412]
LTC/Psych/Other			-0.0572
			[0.0514]
Pediatric			-0.0117
			[0.0999]
Unknown			0.17
			*[0.0266]****
R-sq	0.913	0.913	0.913
N	250,105	250,105	250,105

Notes: Unit of observation is the physician x year. We exclude the transition year from non-VI to VI. Regressions are weighted by Medicare PFS allowed. Standard errors in bracket are clustered by the cartesian product of a physician's main tax ID in each year and the physician's specialty.
For specification (1): Acquirer's inpatient share is calculated at the CBSA level (pooling across years), weighting inpatient admission by DRG wegihts. Regression contains fixed effects for cluster, year x CBSA, and VI x CBSA.
For specification (2): Acquiring system's ownership type is the admissions weighted main ownership type in the 2010 AHA data. Hospitals in the "unknown" category did not match to the AHA.
For specification (3): Service type is determined by matching to the 2010 AHA data and matching based on the system's primary service . Specialty includes specialty specific hospitals such as cardiac or orthopedic hospitals. Hospitals in the "unknown" category did not match to the AHA.
* p<0.10, ** p<0.05, *** p<0.01

Table 6: Effect of PCP VI on Spending: Using Variation in Integration Status of 1st PCP

	Endogenous Regression	First Stage	Reduced Form	IV
	Dep Var = ln(spending)	Dep Var = % of PCP visits VI	Dep Var = ln(spending)	Dep Var = ln(spending)
	(1)	(2)	(3)	(4)
% of PCP visits VI	0.0856			0.0318
	*[0.0221]****			*[0.0120]****
1st PCP integrates		0.798	0.0254	
		*[0.0363]****	*[0.0196]*	
N	1,567,278	1,567,331	1,567,278	1,567,278

Notes: Unit of observation is the enrollee x year for any enrollee who has a PCP E&M visit in the current year and whose "main" PCP in the year is the same as the patient's first "main" PCP. Regressions contain enrollee fixed effects, year x CBSA fixed effects for large CBSAs and year x state Fes for small CBSAs. Standard errors in bracket are clustered by the cartesian product of a physician's main tax ID in each year and the physician's specialty. * p<0.10, ** p<0.05, *** p<0.01

Table 7: Effect of zip code level Vertical Integration on Spending

	Dep Var = ln(mean spending)		Dep Var = ln(median spending)	
	Endogenous	IV	Endogenous	IV
	(1)	(2)	(3)	(4)
Share Primary Care VI	-0.016	-0.0222	-0.0468	-0.0921
	[0.0269]	*[0.0466]*	*[0.0190]***	*[0.0329]****
Share Specialist Care VI	0.352	0.103	0.0897	0.336
	*[0.0349]****	*[0.124]*	*[0.0246]****	*[0.0877]****
R-sq	0.751	0.569	0.904	0.661
N	13,548	13,517	13,531	13,499

Notes: Unit of observation is the zip code x year. Regressions control for zip code fixed effects, cbsa x year fixed effects, zip code HHI and HCCI's estimated average spending for the sample based on age and gender. Regressions are weighted by enrollee months. IV results instrument for both our measures of VI. Point estimates and upper and lower bounds of 95% confidence interval are reported. Standard errors in brackets. * p<0.10, ** p<0.05, *** p<0.01

Table 8: IV Estimates of the Effect of zip code VI on share of spending, by category.

	Dep Var = Share of spending, by BETOS category						
	DME	E&M visits	Imaging	Procedures	tests	Inpatient	Other
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Share Primary Care VI	0.0014	0.00233	-0.0271	-0.00693	0.00626	0.000754	0.0224
	[0.00313]	*[0.00650]*	*[0.0113]*****	*[0.00559]*	*[0.00931]*	*[0.00365]*	*[0.0204]*
Share Specialist Care VI	-0.0181	0.00266	-0.0302	0.0301	0.0229	-0.00818	0.00138
	*[0.00831]*****	*[0.0173]*	*[0.0299]*	*[0.0148]*****	*[0.0247]*	*[0.00968]*	*[0.0541]*
R-sq	0.094	0.154	0.258	0.464	0.119	0.248	0.076
N	13,517	13,517	13,517	13,517	13,517	13,517	13,517

Notes: Unit of observation is the zip code x year. Regressions control for zip code fixed effects, cbsa x year fixed effects, zip code HHI and HCCI's estimated average spending for the sample based on age and gender. Regressions are weighted by enrollee months. Point estimates and upper and lower bounds of 95% confidence interval are reported. Standard errors in brackets. * p<0.10, ** p<0.05, *** p<0.01