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Abstract

This study assessed the relationship between hospital ownership of physician organizations (known as hospital-physician vertical integration) and facility fees billed to commercial insurers and physician service prices. Healthcare claims came from the IBM® MarketScan® Commercial Database (2012–2016, N=30,716,800 office visit claims [CPT codes 99211–99215]), and hospital-physician vertical integration measures were from SK&A Office Based Physicians Database provided by IQVIA. Multi-variate, fixed-effect models were used to regress prices on market-level hospital-physician vertical integration; models included geographic market and year fixed effects, claim-level variables, and time-varying market-level variables. Analyses did not find that market-level hospital-physician vertical integration was associated with the billing of facility fees for office visits. However, vertical integration was associated with office visit physician prices for some specialties. A 10-percentage-point increase in vertical integration was associated with a 1.0% price increase for primary care, a 0.6% increase for orthopedics, and a 0.5% increase for cardiology; no such association was found for obstetrics/gynecology or oncology. When comparing metropolitan statistical areas (MSAs) in the bottom quartile of changes in vertical integration from 2012 to 2016 to MSAs in the top quartile, we found the following relative price increases based on predicted values for claims in the top quartile: \$1.64 (1.9% of mean 2012 predicted price) for primary care to \$2.30 (3.1%) for orthopedics to \$3.13 (3.4%) for cardiology. Differences in predicted price accounted for an estimated \$45.8 million in additional expenditure on primary care office visits in the top quartile of MSAs in 2016. In summary, market-level hospital-physician vertical integration was positively associated with physician prices for select specialties, but was not associated with changes in the use of facility-fee billing. More evidence on the quality effects of hospital-physician vertical integration is needed, as price increases that are not accompanied by measurable quality improvements should be part of any regulatory review.

Keywords

healthcare prices, vertical integration, healthcare market structure

What do we already know about this topic?

The vertical integration of physicians and hospitals or health systems has been consistently associated with the use of facility fee billing and higher physician service prices and spending.

How does your research contribute to the field?

Unlike previous analyses, we did not observe a significant relationship between market-level vertical integration and use of facility fee billing, but we did find a significant association between vertical integration and higher physician service prices.

What are your research's implications toward theory, practice, or policy?

Visits to vertically-integrated physicians may result in higher prices for similar care even if commercial payers require site-neutral reimbursement policies. Existing evidence shows no consistent relationship between vertical integration and quality, but more research in this area is needed. The price increase associated with vertically-integrated physicians may have anticompetitive implications if no significant quality improvements are also associated with this increase.



Introduction and Background

The widespread acquisition of physician practices by hospitals and health systems—a practice known as vertical integration—has been the most significant shift in healthcare provider market structure over the past decade. While further consolidation of already-concentrated hospital and insurance markets is proceeding slowly, the percentage of primary care physicians working in practices owned by a hospital or health system has risen dramatically in recent years, increasing by 57% over the period from 2010 to 2016.¹ This shift in the structure of care delivery systems has been attributed to a range of market and policy incentives in a rapidly-changing healthcare system, and it may have significant implications for insurers, employers, and patients.

Previous literature indicates that vertical integration of physicians and hospitals can lead to higher reimbursement rates.^{2,3} One driver of higher reimbursement for vertically integrated physicians is the addition of facility fees to outpatient services—traditionally reimbursed with only a professional fee—delivered in hospital-owned facilities. CMS is moving to change this policy with the goal of reimbursing providers at the same total level—with total including the professional fee plus any facility fee if charged—regardless of affiliation or place of service, a policy termed “site neutral reimbursement”.⁴ Private insurers may follow CMS’ lead, but recent evidence suggests that patients of vertically-integrated systems may generate higher reimbursement for the same care even under site-neutral payments.⁵

Although economic theory does not suggest a clear relationship between vertical integration and prices in general, recent theoretical work in healthcare economics suggests that there may be plausible circumstances in which providers can integrate vertically in order to increase bargaining leverage, although these studies have not focused specifically on vertical integration of physicians and hospitals.⁵⁻⁷ Empirical analysis shows a consistent relationship between higher prices and vertical integration.^{2,3} We identified a small number of studies that have explored this relationship in the outpatient setting, although studies using inpatient claims have also pointed to higher prices as a result of vertical integration of hospital-based physicians.⁸ Among the analyses estimating the effect of vertical integration on outpatient prices, the study most similar to ours in terms of data and analytic methods is Neprash et al.,⁹ which indicates that price increases, not quantity changes, drive the effect of vertical integration resulting in higher expenditures, and that facility fee billing may not fully account for this price effect.

Two more recent studies on vertical integration and pricing find similar results, finding higher expenditures for patients of vertically-integrated providers. The first study, by Capps et al.,⁵ finds significant provider-level price and expenditure growth relative to non-integrated physicians after integrating with a hospital, and demonstrates that these price effects vary by specialty. Another recent study by Ho et al. found significant expenditures differences associated with integration, although the authors found that this difference was attributable to increased utilization rather than to higher prices. In both Ho et al.¹⁰ and CD&O, claims were provided by a single source that was either located in 1 state or 1 geographic region. Therefore, it is not certain that these findings would generalize to other insurers paying claims to vertically-integrated providers, as the outcomes of price contracting negotiations are understood to be dependent on insurance market structure and the market share of each insurer.

Vertical integration may facilitate improved continuity of care, electronic health record integration, and population health management, but the potential benefits of vertical integration may not be consistently realized.¹¹⁻¹³ The 2 most recent reviews of the literature on vertical integration offer conflicting conclusions on quality, with 1 review arguing that no relationship has been established, while the other contends that while no relationship between vertical integration and patient outcomes has been demonstrated, vertical integration may lead to improved performance on some process of care measures.^{2,3} However, it was unclear in this review whether these process of care measures reflected actual quality improvements or perceived quality improvements.² A more recent study found no association between vertical integration and health outcomes in a large sample of Medicare beneficiaries.¹⁴ Price growth associated with vertical integration may present a policy concern if the potential quality benefits of vertical integration are not consistently realized.

This paper tests 2 hypotheses related to the vertical integration of hospitals and physicians. We hypothesize that as markets vertically integrate, then (1) physicians in more vertically integrated markets will bill a higher share of procedures using the hospital outpatient department (HOPD) place of service code and receive an accompanying facility fee reimbursement, and (2) physicians operating in these more vertically integrated markets will be paid higher prices even when billing only for professional fees using the standard office place of service.

This study adds to the literature on the association between vertical integration and prices for 4 reasons. First, we analyze

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changes from “office” to “HOPD” place of service in outpatient procedure billing as markets vertically integrate. The findings from these analyses suggest that this association—often implicated as a driver of higher prices for vertically integrated physicians—may be weaker than previously thought. Second, we focus on the relationship between vertical integration and physician prices in an analysis that controls for the effects of place of service-based billing changes emphasized in other market-level analyses. This allows us to demonstrate that vertical integration may drive prices higher even under site-neutral reimbursement. Third, we use national price and physician integration data to track a 5-year period over which an unprecedented level of hospital-physician integration occurred, allowing us to estimate the magnitude of price growth resulting from vertical integration. Finally, we utilize a measure of market-level vertical integration that improves upon proxies used in other studies on the effect of vertical integration on negotiated prices, and test this measure using multiple geographic market definitions.

Data and Sample

Data

Data on prices and measures of vertical integration and market structure come from 4 primary sources. We obtained price data from the IBM® MarketScan® Commercial Database (hereafter, MarketScan). Hospital-physician vertical integration and physician organization market concentration measures were based on SK&A Office Based Physicians Database provided by IQVIA, hospital market concentration was based on the American Hospital Association Annual Survey Database, and insurance market concentration was based on Decision Resources Group’s Managed Market Surveyor.

MarketScan data contains claims provided by nearly 350 health insurers and employers nationwide, and it has been used extensively in research on healthcare prices.^{8,9} The number of enrollees in MarketScan data significantly decreases over the study period, as it appears that the number of health plans and self-insured employers providing claims to the MarketScan database decreased. Because the number of health plan claims in the MarketScan data decrease over time at a higher rate than employer claims, we provide a sensitivity analysis limited to claims provided by employers (Supplemental Appendix Table 5).

Sample

Our sample included visits to a physician for established patients (CPT codes 99211-99215) billed in an office setting. These CPT codes were the most common procedures performed across the physician specialty types that we analyzed: primary care, orthopedics, obstetrics and gynecology, cardiology, and oncology. To restrict claims by specialty, we used the specialty code on the claim in MarketScan data (Supplemental Appendix Table 1). For the primary care visit

sample, we restricted claims to a 20% random sample of primary care office visit claims in MarketScan data, due to the amount of computer time needed to estimate the regression models. Our 20% random sample of primary care claims (n=12,315,143) yielded an average of 7844 claims per MSA-year with a range of 29 to 369 693. For the other physician specialty visits, all relevant claims were used.

Analytic samples for all five specialties included claims generated by patients aged 19 to 64 enrolled in PPO plans, which compose the majority (73% for the primary care sample) of the sample for each specialty. Claims were restricted to PPO plans because our research questions were related to the effects of changes in provider market structure, and we sought to reduce any heterogeneity arising from variance on the insurer side of price negotiations. A sensitivity analysis including claims of all plan types is presented in the appendix (Supplemental Appendix Table 6). We excluded any observation with a negative payment, an out-of-network payment indicator, and any office visit CPT codes with a quantity that did not equal one, claims we attribute to billing error.

Claims including facility payments were excluded from the sample, as these are billed using a hospital-associated place of service. This exclusion allows us to test whether vertical integration has a price effect independent of changes in place of service or facility fee billing. Final sample sizes for regression analysis of each specialty were as follows: 12,315,143 for primary care, 5,984,806 for orthopedics, 7,282,747 for obstetrics/gynecology, 3,733,322 for cardiology and 1,400,782 for oncology (30,716,800 claims in total).

Office visit facility fees account for less than 2.5% of all office visit claims in each year of our data, and analysis of MarketScan claims does not indicate a significant relationship between the use of facility fee billing and changes in the share of vertically-integrated providers in a market; therefore, we contend that we do not introduce bias to our market-level regression analysis of prices by excluding these claims. However, to test this assumption, a sensitivity analysis including claims of all place of service types is presented in the appendix (Supplemental Appendix Table 7) and the results are consistent with our primary analysis. The process required to match professional and facility claims in MarketScan data is complicated and inexact, and results in significant shares of missing data that must be imputed.⁹ As a result, we do not explore the additional effect of facility fees billed by vertically-integrated providers on prices, a relationship that has been estimated in detail in prior studies.⁹

Price Measure

The outcome variable is price (or allowed amount), which is the negotiated price between the provider and insurer, before application of coordination of benefits (COB), coinsurance, or other cost sharing payments. Hence, price equals the sum of the amount paid by the insurer plus the patient’s cost sharing responsibility. Price was natural-log transformed, a common practice for healthcare price measures.

Hospital-Physician Vertical Integration Measure

The SK&A data allowed us to create measures of market-level hospital-physician vertical integration by physician specialty. We used the variables denoting hospital or health system ownership (CODE4 and CODE5 in SK&A data) of physician practices to denote vertically integrated physicians. The number of vertically integrated physicians, by market, served as the numerator in our calculation of the percent of physicians practicing in a vertically integrated setting, while the total physician FTEs of the specialty in the market served as the denominator.

Ideally we would have linked physicians in SK&A to MarketScan claims, but this was not possible because MarketScan data did not include a provider identifier that could be linked to SK&A data. However, our measure of hospital-physician vertical integration improves upon previous market-level analyses of the effect of vertical integration on pricing, which have either used the percentage of Medicare claims originating from the HOPD setting or affiliated provider data listed by hospitals participating in AHA surveys to estimate market-level vertical integration.^{8,9} The SK&A physician data allow us to directly measure which physicians became employed by organizations owned by hospitals, rather than relying on a proxy or aggregated hospital survey responses.

Market Concentration Measures

Several studies have found that healthcare market concentration affects healthcare prices.¹⁵ To measure market concentration, we use the Herfindahl-Hirschman Index (HHI), a commonly used measure by the Antitrust Division of the Department of Justice (DOJ) and Federal Trade Commission (FTC).¹⁶ The HHI is calculated by squaring the market shares of each firm competing in a market and summing those values across all firms, resulting in a range from 0 to 10000, which we scaled from 0 to 1 for ease of interpretation. Because insurer-provider contracts are not negotiated during the year in which procedures are performed and many last multiple years, we utilize 2-year lagged measures of market concentration in our statistical analysis.

To estimate HHIs for physician, hospital, and insurer markets, we relied on the methods described in Fulton.¹ Hospital market shares were based on the number of admissions (including summing admissions across hospitals within a system in a market), physician organization market shares were based on the number of full-time-equivalent physicians, and insurer market shares were based on the number of enrollees. These market shares were used to estimate HHIs in 2 geographic markets: an MSA served as the market for our primary analyses, and a county served as the market for our sensitivity analyses. HHIs for primary care physician organizations were calculated at the Primary Care Service Area (PCSA) level and then aggregated to the MSA or county

level by calculating the mean HHI of the PCSAs at the aggregated level weighted by the number of full-time-equivalent primary care physicians in a PCSA. HHIs for other specialty physician organizations were calculated directly at the MSA level.

Methods

This section includes the methods used to test our 2 hypotheses for vertically integrated physician markets, including facility fees and place of service and professional fee prices.

Facility Fees and Place of Service

Under Medicare reimbursement, vertically integrated providers are able to bill outpatient procedures with an accompanying facility fee by shifting care to a practice location with a place of service that allows facility fees to be billed. When visits are billed out of an HOPD, the physician payment is smaller than an equivalent service billed in a traditional office visit setting, but total reimbursement increases when including the facility fee. As many payers follow Medicare billing rules generally, it has been theorized that the use of the HOPD facility fee occurs with private insurer claims as well, and empirical work has demonstrated that patients of vertically integrated providers are more likely to receive care in an HOPD place of service.¹⁷ Under Medicare rules, a claim billed in this manner must use an HOPD or other hospital-owned place of service type. The HOPD was the only place of service code used to bill facility fees at a significant share in our data.

In order to assess the relationship between vertical integration and facility fees and place of service billing, we used descriptive statistical analyses on a slightly different sample from those in the regression analyses we estimate on professional physician visit prices. This sample is a 20% random sample of all in-network, fee-for-service office visit claims (not restricted by physician specialty) with CPT codes 99211 to 99215 from the years 2012 and 2016 present in IBM MarketScan Commercial Database (n=20 134 232 in 2012 and n=11 181 092 in 2016).

Table 1 and Figure 1 present our descriptive analysis on facility fees and place of service. Table 1 tabulates these claims by place of service and whether they were billed with professional fees only or professional and facility fees. Figure 1 presents a scatter plot of MSAs by change in vertical integration over the study period and change in percent of office visit claims billed using an HOPD place of service over the study period. Figure 1 also includes a simple regression using vertical integration changes to predict changes in billing of HOPD place of service, along with 95% confidence intervals of this regression line. We do not lag the vertical integration measure in this scatter plot, as physicians could change place of service immediately following acquisition by a hospital.

Table 1. Facility/Professional and Place of Service Billing by Year, 20% Sample of Office Visit Claims in IBM MarketScan Commercial Database.

Place of service	2012		2016	
	N	%	N	%
Office	18 992 036	94.33	10 334 492	92.43
HOPD	839 069	4.17	489 957	4.38
Provider-based dept.	0	0	9326	0.08
Urgent care	205 604	1.02	242 194	2.17
Other	97 523	0.48	105 123	0.94
Total*	20 134 232	100	11 181 092	100

Claim type	n	%	N	%
Facility	463 007	2.3	250 854	2.24
Professional	19 671 246	97.7	10 930 369	97.76
Total	20 134 253	100	11 181 223	100

*Twenty-one claims in the 20% sample had no place of service code in 2012, in 2016 this number was 131. These missing claims account for the discrepancies between totals within *n* columns. Office visit claims in this sample were all established patient office visit CPT codes (99211-99215). Source: Authors' analysis of IBM MarketScan Commercial Database (2012-2016)

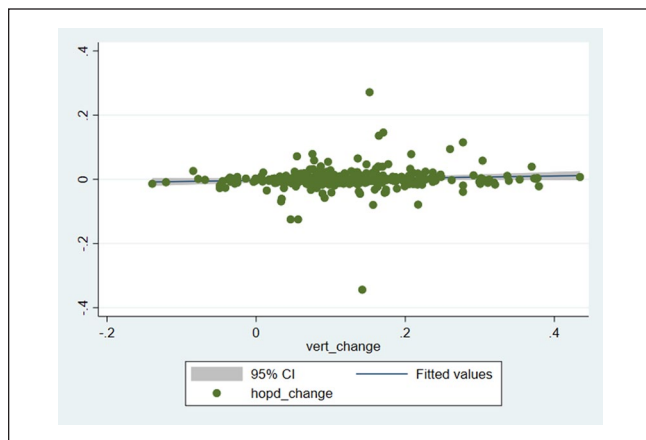


Figure 1. Change in vertical integration* and change in percentage of all office visit claims billed with an HOPD place of service from 2012 to 2016.

*Change in vertical integration measured as change in share of total physician FTEs in an MSA working in practices owned by a hospital or health system. Confidence intervals cross 0, indicating that a regression of vertical integration change (x axis) on change in the percentage of office visits billed with HOPD place of service (y axis) does not suggest a significant relationship between these 2 variables.

Source: Authors' analysis of IBM MarketScan Commercial Database (2012-2016) and other datasets listed in the methods.

Conceptual Framework to Analyze Vertical Integration and Physician Prices

The conceptual framework relating vertical integration to physician prices is based on Nash bargaining models, in which the relative market power of the insurer and physician

determine a price level.^{15,18} Under this framework, physician groups that affiliate with hospitals or health systems may improve their bargaining position in price contracting because of the hospital's greater relative market power, but this increase in market power may also be influenced by vertical foreclosure. Vertical foreclosure is an anticompetitive strategy whereby upstream and downstream firms—in this case, hospitals and physicians—merge in order to receive privileged access to a necessary input relative to competitors, thereby increasing market power.^{3,19-21} For instance, a hospital may purchase local physician groups in order to achieve more referrals, which reduces referrals to competitor hospitals. Theory predicts that vertical foreclosure increases market power of vertically integrated firms, particularly in highly concentrated markets, such as those in the healthcare industry. To empirically test this conceptual model, we estimate a reduced form regression model (see equation (1) below).

Physician Price Statistical Model

To estimate the relationship between hospital-physician vertical integration and the price for a physician office visit, we estimated regression models with market and year fixed effects and additional controls using Stata 14 (equation (1)). Separate models were estimated for each of the 5 physician specialties—primary care, orthopedics, obstetrics and gynecology, cardiology, and oncology—for 2 different market definitions, MSA and county. Standard errors were estimated by clustering at the market level.

$$\ln(\text{Price}_{\text{cmt}}) = B_1 + B_2(\text{Market}_m) + B_3(\text{Year}_t) + B_4(\text{VI}_{\text{mt}-2}) + B_5(\text{Market HHI}_{\text{mt}-2}) + B_6(\text{Claim}_{\text{imt}}) + B_7(\text{Wage}_{\text{mt}}) + E_{\text{cmt}} \quad (1)$$

In equation (1), “c” indexes claims, “m” indexes markets, and “t” indexes year, and the variables are defined as follows. Price is the amount paid for the claim. Market is a set of dummy variables representing each MSA, and year is a set of dummy variables representing each year (reference year is 2012). The “VI” (hospital-physician vertical integration) term is the primary regressor of interest, representing the share of vertically integrated physicians in each market. “Market HHIs” is a vector of market-level HHI measures for physicians, hospitals, and insurers. The VI and market HHIs are lagged by 2 years to reflect that insurer-provider contracts typically span at least 1 year. Claim is a vector of claim-level variables that include the CPT code, procedure modifiers, and provider type. The CPT code is represented by a dummy variable for each of the 5 codes (99211-99215; reference code is 99211), which are used for standard office visits with established patients. The codes increase based on the intensity of the visit, with 99211 representing the shortest and least complex visit, and 99215 representing the longest and most complex visit. The procedure modifiers include a

dummy variable for each modifier present in the physician specialty, ranging from 31 unique modifiers in the oncology visit model to 123 unique modifiers in the primary care visit model. CPT code modifiers relay information to the payer about the circumstances and details of the services performed during the visit that do not change the CPT code, but which may affect price. The provider type variable designating family versus internal medicine is only included in the primary care visit model because the other visit models include only 1 provider type. Wage is a market-level variable that reflects underlying costs to provide services in a market, represented by average weekly wages.²²

By restricting our sample to only claims with an office visit place of service, we excluded claims that would generate facility fees, allowing the analysis to track how changes in vertical integration affect prices for office visits without observing additional billing changes that may result from vertical integration. To address the potential for bias arising from excluding claims with place of service codes other than “office,” we conducted a sensitivity analysis including claims from all place of service codes. Results of this analysis are presented in the appendix (Supplemental Appendix Table 6).

To compare physician price growth between 2012 and 2016 in markets with the highest change in hospital-physician vertical integration (defined by the top quartile of markets) with the lowest change in hospital-physician vertical integration (defined by the bottom quartile of markets), we re-transformed estimated prices from the natural log scale using Stata’s user-written *levpredict* command to calculate the mean price increase in each quartile.¹⁷

Results

In order to test hypothesis 1, we analyzed changes in the billing of facility fees alongside market-level changes in hospital-physician vertical integration. Using the analytic sample described in the “Facility Fees and Place of Service” section, we find relatively little change in billing of facility fees for office visit procedures, which are the most common procedures performed by the physicians in our sample (Table 1). In 2012, 2.30% of the sample of office visit procedures were billed as facility charges, while in 2016, 2.24% of the sample were billed as facility charges. We also detected little change from 2012 to 2016 in the billing of HOPD place of service type. In 2012, 4.17% of the total office visit sample was billed using the HOPD place of service type (22), while in 2016, 4.38% of the total office visit sample was billed using the HOPD place of service type. This is a relatively low share of HOPD billing given the high level of vertical integration by the end of our study period. We also did not observe a significant correlation between within-market changes in HOPD billing and changes in market-level vertical integration (Figure 1). This result is surprising, given that this association has been demonstrated in prior studies.^{5,17} Ho et al.¹⁷ found a

relatively small increase in likelihood of outpatient facility fee claims over an observation year associated with patients of vertically-integrated providers (39.1% vs 47.9%), but this small effect may be attenuated in a market-level analysis. Additionally, it may be possible that some payers providing data to MarketScan databases during this period already employed policies that did not incentivize facility fee billing, such as site-neutral reimbursement.

Table 2 shows the descriptive statistics for the analytic sample when the market is defined by an MSA. In each physician specialty, the price of an office visit increased during between 2012 and 2016, ranging from a 12% increase in obstetrics and gynecology visits to an 18% increase in oncology visits (see Figure 2a for more detail). In each physician specialty, the share of vertically integrated physicians significantly increased between 2012 and 2016, including increasing from 27% to 40% for primary care physicians (see Figure 2b for more detail). The HHI levels increased for physician organizations and hospitals, but slightly decreased for insurers. The number of claims decreases during the study period; for example, the number cardiology office visits decreased by nearly 50%. Despite this diminishing sample size, our sample had claims from a similar number of MSAs in each year of the study period. We additionally conducted a sensitivity analysis using only claims provided by employers, which decreased less over time. See Supplemental Appendix Table 5 for more information.

Figure 2a shows the growth in mean price of an established patient office visit over time among the estimation sample, by specialty. Oncology was the most expensive specialty by negotiated price at the beginning and end of the study period, while obstetrics and gynecology was the least expensive specialty. Growth rates in prices were relatively consistent across all specialties.

Figure 2b shows the growth over time in vertical integration by specialty among the estimation sample. In addition to being the most expensive specialty, oncology was also the most vertically integrated. SK&A data indicates a small decrease in levels of vertical integration of oncologists in 2013 that does not appear consistent with other specialties, and we attribute this to noise in the data. Orthopedics was the least vertically integrated at the outset of the study period, but this specialty integrated rapidly and was similar to Ob/Gyn by the end of the study period.

We examined the price regression coefficient estimates for our vertical integration measure to test our second hypothesis, and found a significant association at the 0.05 level (or lower) between lagged vertical integration and professional fee prices for primary care, cardiology, and orthopedics claims billed with an “office” place of service (Supplemental Appendix Table 2 presents descriptive statistics for county level samples, regression results are available in Supplemental Appendix Table 4). The vertical integration coefficient was largest in the primary care sample (0.001) and smaller in the orthopedics and cardiology samples

Table 2. Characteristics of the Analytic Sample of IBM MarketScan Commercial Database Office Visit Claims by Physician Specialty Type (MSA Analytic Samples).

	Primary care		Orthopedics		Ob/Gyn		Cardiology		Oncology	
	N		N		N		N		N	
Number of claims										
2012	3 518 785		1 580 787		2 138 651		1 008 840		412 210	
2016	1 712 953		919 223		1 050 632		564 476		211 942	
Number of MSAs										
2012	314		316		318		316		305	
2016	314		319		319		317		298	
Average weekly wage (\$)										
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
2012	945.10	245.02	967.69	248.19	985.30	267.57	980.29	264.93	981.01	250.84
2016	1005.84	253.83	1024.10	256.22	1051.70	295.77	1064.97	305.34	1054.92	288.71
Price (\$)										
2012	89.30	35.04	79.95	31.83	79.11	35.89	92.11	39.37	102.48	64.96
2016	100.23	42.76	91.00	37.87	88.46	43.17	106.34	46.81	121.05	65.22
Share of physicians vertically integrated										
2010	27%	15%	15%	12%	21%	15%	20%	18%	33%	22%
2014	40%	17%	32%	19%	33%	20%	50%	25%	53%	24%
Physician specialty HHI										
2010	1230.44	722.93	1279.98	1570.37	679.86	986.74	1404.77	1819.34	2376.35	2328.63
2014	1558.16	904.97	1486.61	1543.70	919.56	1126.79	1538.06	1575.71	2859.35	2041.96
Hospital HHI										
2010	2596.09	2204.31	2489.56	2132.33	2351.04	2095.68	2382.15	2100.42	2507.19	2029.62
2014	2852.40	2241.86	2739.91	2069.94	2642.70	2115.64	2548.76	2142.94	2724.98	2027.53
Insurer HHI										
2010	2503.28	761.12	2501.30	745.60	2519.85	767.86	2457.91	737.65	2444.12	696.89
2014	2439.98	756.25	2472.08	753.20	2426.57	744.08	2437.92	767.56	2443.21	693.03

Source. Authors' analysis of IBM MarketScan Commercial Database (2012-2016) and other datasets listed in the methods.

Note. The table shows the first and last year of the study period, and the unit of observation is an office visit healthcare claim. Market structure variables (share of physicians vertically integrated, physician specialty HHI, hospital HHI, and insurer HHI) are lagged by 2 years. The HHI measures vary by office visit physician specialty type because the geographic distribution of claims slightly varies by office visit physician specialty type. The HHI levels are lower than reported in Fulton (2017), which reported the mean HHI levels across MSAs that were not weighted for population, whereas the HHI levels in this table reflect that a larger number of claims originate from more populous MSAs, which have lower HHI levels.

(0.0006 and 0.0005, respectively). A 10 percentage point increase in vertical integration at the market level was associated with a 1.0% price increase in office visit prices for primary care, a 0.6% increase in prices for orthopedics, and a 0.5% increase for cardiology. No significant association was observed between vertical integration and office visit prices for physicians in obstetric/gynecology or oncology specialties.

In order to contextualize the associations between vertical integration and natural log of prices, we plot mean predicted prices (Figure 3) for an established patient office visit of medium intensity (99213) at the bottom and top quartiles of markets by vertical integration change over the study period (excluding obstetrics and gynecology and oncology, as the coefficients for these specialties were not significant). MSAs in the top quartile for the change in primary care vertical integration averaged a 32.2 percentage point increase over the study period, while MSAs in the bottom quartile averaged a 1.3 percentage point increase. For orthopedics, these respective values were 45.2 versus -5.5 percentage points, and for cardiology these respective values were 54.3 versus

-4.2 percentage points. Predicted price growth in the top vs bottom quartile MSAs was \$1.64 higher for primary care visits (\$6.76 vs \$5.12), \$2.31 higher for orthopedic visits (\$8.78 vs \$6.47), and \$3.13 higher for cardiology visits (\$9.62 vs \$6.49). These differences in predicted price growth between bottom and top quartiles in terms of vertical integration change range from 1.9% to 3.4% of 2012 prices for patients in the highest quartile of vertical integration. CD&O estimated that, among their claims sample, vertical integration led to a 1.3% price increase in aggregated physician prices relative to a counterfactual in which vertical integration had remained constant over their study period (2007-2013). Our estimates are somewhat larger and occurred over a slightly shorter—5-year versus 7-year—period of time.⁵

We estimated the effect of the price growth differences in our MSA level regressions on expenditures in the top and bottom markets by quartile of vertical integration. The top quartile of MSAs in our analysis had 13.96 million covered lives in 2016 per the DRG Managed Market Surveyor File. Assuming 2 office visits per year, with an additional \$1.64 spent on each office visit (using the predicted price difference

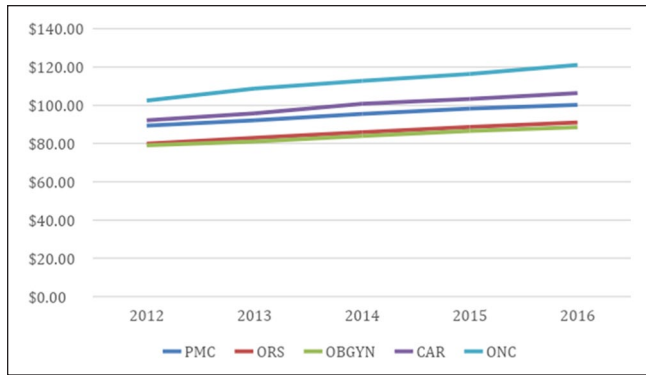


Figure 2a. Mean office visit price by physician specialty and year (MSA analytic samples).

Source. Authors' analysis of IBM MarketScan Commercial Database (2012-2016).

Note. PMC denotes primary care, ORS denotes orthopedics, OBGYN denotes obstetrics and gynecology, CAR denotes cardiology, ONC denotes oncology. Means were estimated from individual claims in specialty-specific analytic samples.

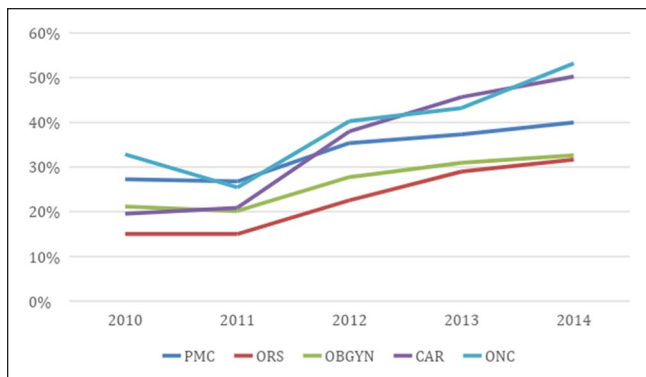


Figure 2b. Mean vertical integration share by specialty and year (MSA analytic samples).

Source. Authors' analysis of SK&A Office Based Physician Database provided by IQVIA.

Note. PMC denotes primary care, ORS denotes orthopedics, OBGYN denotes obstetrics and gynecology, CAR denotes cardiology, ONC denotes oncology. Figure 2b presents the share of vertically integrated physicians from 2010 to 2014, a 2-year lag from the 2012 to 2016 price variables. The vertically integrated share means were estimated from the provider's MSA on individual claims.

between lowest and highest quartiles of vertical integration change for a primary care visit over the study period), the privately-insured population in these MSAs cost an estimated additional \$45.8 million, solely as a result of price difference in physician office visits. This expenditure increase may be borne by employers and patients, as insurers in many geographic markets appear to have the market power to pass provider price increases on during premium negotiations with employers.²³

The results in our county level sensitivity analysis (Supplemental Appendix Table 4) are smaller in magnitude,

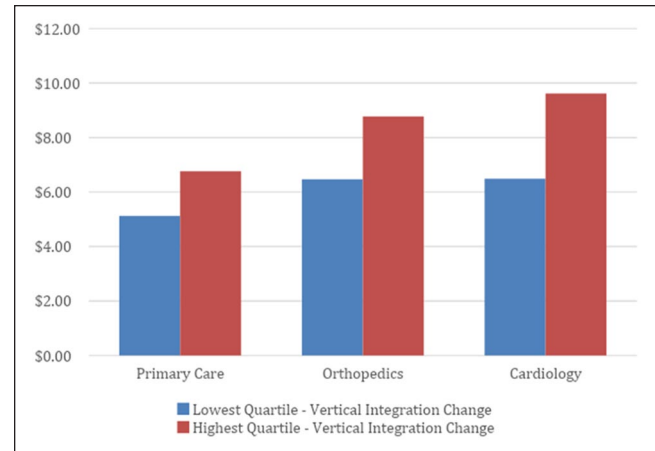


Figure 3. Mean change in predicted price for medium-intensity office visit (CPT 99213) from 2012 to 2016, by physician specialty and quartile of vertical integration change (MSA analytic samples).

Source. Authors' analysis of IBM MarketScan Commercial Database (2012-2016) and other datasets listed in the methods.

Note. Figure 3 plots the mean change in predicted price by physician specialty from 2012 to 2016 for the bottom and top quartiles of MSAs defined by the change in the share of vertically integrated physicians from 2010 to 2014 (because this measure was lagged by 2 years). Only physician specialties with significant vertical integration coefficients in regression analysis (Supplemental Appendix Table 3) are included in this figure. Predictions generated from the regression model were in units of natural log of prices, which were transformed to levels using $-\text{levelpredict-}$.

but are generally consistent with those in our MSA-level models, suggesting these findings are not sensitive to geographic market definition. We also found similar results in our sensitivity analysis restricting claims to those provided by employers (Supplemental Appendix Table 5) as opposed to health plans, as this subsample has a more consistent sample size over time. See appendix for further discussion.

Discussion

This study found that hospital ownership of physician organizations—also called hospital-physician vertical integration—was associated with higher physician prices for primary care, orthopedics, and cardiology office visits, but was not associated with higher physician prices for obstetrics/gynecology and oncology visits. Furthermore, hospital-physician vertical integration was not significantly associated with the use of hospital outpatient department (HOPD) as the place of service. The professional fee price results are comparable to a prior study that estimated the relationship between vertical integration and professional fee prices; hence, our results add to a growing body of literature demonstrating that vertical integration of hospitals and physicians is associated with higher physician prices.^{3,5}

While site-neutral payments may rein in price growth resulting from vertical integration under CMS reimbursement,

our analysis suggests that commercially-insured patients of vertically-integrated providers will still generate higher reimbursement under site-neutral payments. We estimate that insurers, employers, and patients in MSAs with the greatest magnitude of change in vertical integration by quartile paid an additional \$45.8 million solely for primary care office visits in 2016, in comparison to those payers in MSAs in the lowest quartile.

We identify several limitations with our study. Our finding that the uses of HOPD as a place of service and facility fee billing do not appear to increase significantly with higher shares of vertically-integrated physicians in a market may be particular to the reimbursement practices of MarketScan data providers, and therefore may not generalize to the ways in which physicians bill other payers, such as Medicare. Further, while market-level fixed effects limit the presence of omitted variable bias in our empirical analyses, we are unable to rule out the biasing effects of a potentially endogenous relationship between vertical integration and pricing. For instance, hospitals may acquire physician organizations with limited market power because these combined entities are able to negotiate higher prices. However, our results appear to be consistent with findings of studies such as CD&O, which use different study designs that may better address this potential endogeneity.⁵ Additionally, geographic markets are noisy and imperfect proxies for healthcare services markets, with MSAs and populous counties often too large—or in the case of some rural counties, too small—to reflect competitive dynamics for providers treating the patients that live within them. We test the effects of vertical integration using multiple market boundaries to address this limitation. Without the ability to identify individual providers within our data, we cannot observe a provider-level price effect of vertical integration, and we are also unable to control for each provider's market power, an important and time-varying determinant of pricing. Observing the effects of vertical integration on prices at a market level may bias our results toward the null, as even in highly-concentrated markets, we likely observe some claims from non-integrated providers. This attenuation of effect may also explain the insignificant relationship between vertical integration at the market level and use of HOPD place of service observed in our analysis. Although observing changes in market-level vertical integration while controlling for market factors with market fixed effects and market concentration is a strong study design that points to an association between vertical integration and prices, future work should continue to investigate this relationship with provider-level data. Finally, there is significant attrition in the IBM MarketScan data over the course of our study period, which our analysis indicates is the result of health plans dropping out of the dataset in later years. Changes in our sample over time may have confounded our analyses (including the hospital and physician HHI coefficient estimates); however, we found similar vertical integration results when we restricted the

sample to claims provided by a subsample of self-insured employers, which was more consistent in number over time.

The empirical literature does not indicate significant and consistent quality improvements associated with vertical integration, but the results of our study, taken along with the results of previous work, suggest that higher prices for comparable services appear to be associated with hospital-physician vertical integration.^{2,3,14} Our findings are relevant to regulators considering the effects of consolidation in health-care, because price increases that are not accompanied by measurable quality improvements should be part of any regulatory review.

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Supplemental Material

Supplemental material for this article is available online.

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