NBER WORKING PAPER SERIES

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Working Paper 23871
http://www.nber.org/papers/w23871

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
September 2017

We would like to thank Aileen Devlin for exceptional research assistance and Jonathan Levin, Richard Lindrooth, and other participants at ASHEcon for helpful comments. All errors are our own. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

At least one co-author has disclosed a financial relationship of potential relevance for this research. Further information is available online at http://www.nber.org/papers/w23871.ack

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JEL No. I11

ABSTRACT

In markets for health services, vertical integration – common ownership of producers of complementary services – may have both pro- and anti-competitive effects. Despite this, no empirical research has examined the consequences of multispecialty physician practice – a common and increasing form of vertical integration – for physician prices. We use data on 40 million commercially insured individuals from the Health Care Cost Institute to construct indices of the price of a standard office visit to general-practice and specialist physicians for the years 2008-2012. We match this to measures of the characteristics of physician practices and physician markets based on Medicare Part B claims, aggregating physicians into practices based on their receipt of payments under a common Taxpayer Identification Number. Holding fixed the degree of competition in their own specialty, we find that generalist physicians charge higher prices when they are integrated with specialist physicians, and that the effect of integration is larger in uncompetitive specialist markets. We find the same thing in the reciprocal setting – specialist prices are higher when they are integrated with generalists, and the effect is stronger in uncompetitive generalist markets. Our results suggest that multispecialty practice has anticompetitive effects.

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1. Introduction

Economists have long understood that vertical integration – common ownership of producers of complementary services – may have both pro- and anti-competitive effects (Joskow 2005). In markets for health services, vertical integration is particularly important. There is almost universal agreement that closer relationships between providers of complementary services have the potential to improve communication and coordination, thereby enhancing the quality or reducing the cost of care. At the same time, there is also evidence that vertical integration may enhance providers' market power and increase prices.

This literature, however, has focused almost exclusively on integration between hospitals and physicians; the phenomenon of integration of physicians of different specialties has received significantly less attention. The lack of research on the consequences of multispecialty practice for prices and competition is surprising, since the majority of physicians work in a multispecialty practice and the share is increasing (Welch et al. 2013). In theory, the same mechanisms through which hospital/physician integration operates may also determine the consequences of integration among physicians.

This paper seeks to fill this gap. We study empirically the relationships between prices paid by commercial health plans to generalist and specialist physicians when they are in practices that also include their complementary colleagues. Holding fixed the degree of competition in their own specialty, we find that generalist physicians charge higher prices when they are integrated with specialist physicians, and that the effect of integration is larger in uncompetitive specialist markets. We find the same thing in the reciprocal setting – specialist prices are higher when they are integrated with generalists, and the effect is stronger in uncompetitive generalist markets. Our results suggest that multispecialty practice has anticompetitive effects.

Our paper proceeds in five parts. Part 2 discusses previous research on the effects of vertical integration on competition in markets for health care, focusing on the theoretical reasons why integration between generalists and specialists may enhance market power and increase prices, and describes the analytic approach we take. Part 3 explains how we calculate the prices paid to generalist and specialist physicians using data from the Health Care Cost Institute (HCCI), and the extent of the market power of and integration between generalists and specialists from Medicare claims, both at the ZIP code level. Part 4 presents our models of the effects of generalist/specialist integration on prices and our results, and Part 5 concludes.

2. Previous research and analytic approach

Economic theory offers several hypotheses about the effects of vertical integration in general (Bresnahan and Levin 2012), and multispecialty practice in particular, on markets for health services. One class of models suggests that multispecialty practice could improve productive efficiency. These models emphasize how multispecialty practice improves physicians' ability to coordinate care and referrals through "one-stop shopping" (Burns, Goldsmith, and Sen 2013). A second class of models shows how integration among physicians of different specialties can reduce double marginalization (Spengler 1950) – multiple markups by different physicians, each of whom has some market power.

A third class of models hypothesizes that physicians join multispecialty practices in order to make or receive hidden payments for referrals (Pauly 1979). Explicit "kickback" payments to referring physicians are banned by law in the Medicare and Medicaid programs, and banned by contract in essentially all commercial health plans, but enforcement of a ban on transfers across specialties within a practice is difficult or impossible. Models of hidden kickbacks therefore predict that multispecialty practices might couple a policy of referring patients within the practice with higher generalist prices, in order to compensate referring generalists for the extra revenue that they generate for referred-to specialists.

A fourth class suggests several channels through which multispecialty practice could be anticompetitive. Some of these models explain how vertical integration can be used in the same way as tying in order to facilitate price discrimination (Perry 1989). According to these models, integration could enable generalist and specialist physicians to extract greater rents from consumers in aggregate if consumers who value specialists more highly also demand more frequent generalist visits. Other models explain how vertical integration can foreclose competition (e.g., Whinston 2006). According to these models, generalist-specialist integration could enhance specialists' market power and increase prices if it enables specialists to deprive their rivals of the referrals from the generalists with whom they affiliate.

In markets with purchasing intermediaries, like health insurers, vertical integration can enhance market power in another way. In this context, joint bargaining increases suppliers' market power because it enhances the suppliers' ability to deny the intermediary's customers the benefits of their complementarity – benefits which the suppliers can jointly offer to one of the intermediary's competitors (Peters 2013). In the presence of an intermediary like a health insurance plan constructing a network of providers, joint bargaining among producers of complements raises prices in much the same way as joint bargaining among producers of substitutes. In both cases, it allows the suppliers to internalize and profit from contracting externalities which would have otherwise flowed to consumers' benefit.

This work also highlights that changes in unit prices to physicians are not the only way that multispecialty practice can be used to extract surplus from consumers. For example, Peters (2013) shows that in equilibrium multispecialty practices may extract surplus through lump-sum transfers from intermediaries who pass on that cost to consumers in the form of increased premiums. However, a positive effect of multispecialty practice on *all* of the unit prices of physicians in the practice is sufficient (although not necessary) to reject the absence of anticompetitive effects. An increase in all of the prices is inconsistent with models in which multispecialty practice enhances productive efficiency, reduces double marginalization, or facilitates welfare-enhancing price discrimination. It also cannot be explained by a model of hidden kickbacks. Hidden-kickback models can only explain increases in the unit price of *referring* physicians -- the gain to the referred-to physician arises out of an increase in quantity.[1]

To investigate the validity of these theories, we begin by testing whether the prevalence of multispecialty practice in a small geographic area affects the price for a standard generalist (specialist) physician office visit, holding constant the characteristics of the market for generalist (specialist) services; patient characteristics; the procedure-code mix of office visits; the cost of medical care; the mix of patient age, gender, and plan types; and area- and time- fixed effects. A positive effect of multispecialty practice on both generalist and specialist prices in these models would suggest a net anticompetitive effect; a negative effect on both generalist and specialist prices would suggest a procompetitive effect; and opposing effects would be inconclusive.

This interpretation, however, depends on the assumption that there are no unobserved differences in quality, conditional on our observed covariates, that are correlated with the extent of multispecialty practice. In particular, if multispecialty practice leads to both higher unobserved quality and higher prices, or areas with increases in multispecialty practice experience other unobserved changes that would lead to higher prices or quality, then a positive estimated effect of multispecialty practice on prices would not necessarily be anticompetitive. Even it is implausible to assume that unobserved differences in quality would be of sufficient magnitude to outweigh observed price increases, simple hypothesis tests of the partial correlation between multispecialty practice and price cannot rule them out.

[1] Indeed, the model in Pauly (1979) shows how payments for referrals can erode specialist market power.

To exclude this possibility, we test for a second effect: a positive interaction effect between the extent of a physician's integration with a complementary colleague and the competitiveness of the complementary colleague's market, holding constant the competitiveness of the physician's own market and all of the factors described above. Such an effect is a possible consequence of all of the models that predict anticompetitive price increases from multispecialty practice, but would be extremely implausible to be due to unobserved differences in quality.

Our analysis begins with models of the form:

$$p_{j,t}^{s} = \beta_1 HHI_{j,t-k}^{s} + \beta_2 d_{j,t-k}^{-s} + \beta_3 (d_{j,t-k}^{-s} \times HHI_{j,t-k}^{-s}) + \gamma_z + \delta_s + \theta_t + \varepsilon_{j,t}^{s} \quad (1)$$

where $p_{j,t}^{s}$ is an index of the price of physician services -- standardized for patient characteristics, procedure mix, and input costs – to physicians in practice j = (1,...,J) of specialty s = (generalist, specialist) at time t = (1,...T). HHI^{s} and HHI^{-s} denote Herfindahl-Hirschman concentration indices for physicians of specialty s, and not of specialty s, respectively; and $d_{j,t}^{-s}$ is an indicator taking the value 1 for practices in which specialties other than s are present. HHIs are a standard measure of the competitiveness of markets, here defined as the sum of the squared market shares of practices serving a market. The HHI will approach 0 for markets served by a large number of practices, each with a small market share. HHIs increase as the number of practices serving the market declines, and when the market share of any one practice increases relative to the others. HHIs presented in this paper are scaled so they reach a maximum of 1 in a monopoly market. As we explain in detail below, we computed the HHIs using an approach that we have used in previous work, modified to incorporate the FTC and DOJ recommendations for measuring the market competitiveness facing Accountable Care Organizations (Baker et al. 2014; Federal Trade Commission 2011). We allow both the *HHI* measures and d to affect prices with a lag of k years to account for the fact that prices at time t will generally be a function of negotiations with health plans conducted in earlier years; in our basic model we use a three-year moving average lag structure, but also present results from models that use a simple one-year lag.

γ captures fixed differences across zip codes of patient residence; δ captures differences across specialties; and θ captures trends over time. In this model, β_1 measures the effect of own-specialty HHI on prices, β_2 the effect of integration with other specialties, and β_3 the incremental effect of integration for physicians in practices in which their complementary colleagues have market power. This model implicitly assumes that the competitiveness of the market for physicians other than specialty *s* does not affect the price of services of physicians of specialty *s*, except insofar as those physicians work together in an integrated practice. Indeed, single-specialty practices do not have a defined value for HHI^{-s}. We examine the validity of this assumption in greater detail below.

We expand our basic model in two ways. First, we allow the effect of integration to vary with the competitiveness of a physician's own market as well as the competitiveness of the market of the physician's complementary colleagues:

$$p^{s}_{j,t} = \beta_1 HHI^{s}_{j,t-k} + \beta_2 d^{-s}_{j,t-k} + \beta_3 (d^{-s}_{j,t-k} \times HHI^{s}_{j,t-k}) + \beta_4 (d^{-s}_{j,t-k} \times HHI^{-s}_{j,t-k}) + \gamma_z + \delta_s + \theta_t + \varepsilon^{s}_{j,t} \quad (2)$$

Second, we estimate models derived from (1) and (2) based exclusively on specialist physicians. In these models, instead of specialty *s* = (generalist, specialist), we define specialty *s* = (specialist of type *s*, specialist of type -*s*).

Three recent papers have examined a closely-related question: whether physician/hospital integration enhances provider market power. Baker, Bundorf, and Kessler (2014) construct county-level indices of the price of hospital services using claims from the nonelderly privately insured from Truven Analytics for 2001-07, matched with data on the types of relationships hospitals have with physicians from the American Hospital Association. They find that increases in the market share of hospitals that own physician practices are associated with higher hospital prices and spending. Neprash et al. (2015) construct MSA-level indices of inpatient and outpatient spending using Truven claims for 2008-12, matched with data on the extent of physician/hospital integration based on Medicare outpatient billing patterns. They find that increases in the market share of hospitals that are integrated with physicians are associated with statistically significantly higher outpatient spending. Capps, Dranove, and Ody (2015) show that integration of a physician's practice with a hospital was associated with price increases for the integrated physician group of 14 percent on average, also holding constant other market characteristics, with larger effects when the integration was undertaken by a larger hospital. Whether vertical integration among complementary physicians has similar effects is the question to which we now turn.

3. Empirical approach

Ideally, we would estimate equations (1) and (2) with data at the physician practice level on prices, integration, and market power. However, we were unable to obtain complete data on physician prices that identified practice group, and so were unable to match to prices information on the extent of integration across specialties at the practice level. Lacking practice-level data on prices and integration, we estimate our models instead at the ZIP code level. We construct ZIP code-year level generalist and specialist physician price indices for 2008-12 using data from the Health Care Cost Institute (HCCI). HCCI is an independent, nonprofit research institute that operates with the goal of advancing knowledge on health care use and spending in the US. The HCCI data include information from Aetna, Humana, and United HealthCare on approximately 40 million individuals from all 50 states, accounting for 27% of the nonelderly population covered by private health insurance, and is beginning to be used by other to study the effects of market structure on prices (Cooper et al. 2015).

We match to these indices ZIP code-year level measures of the characteristics of physician practices and physician markets based on Medicare Part B claims filed by physicians for the care of a 20% random sample of traditional Medicare beneficiaries for 2006-12. Medicare claims reflect care delivered by a very large share of active physicians and we expect the set of physicians who billed traditional Medicare to substantially overlap with the set of physicians who provided services to privately insured patients in the HCCI data.[2] Each claim reports the tax ID number (TIN) of the physician's practice, the physician's specialty, and the physician's and patient's zip codes, among other things. We define a physician's practice as the set of physicians who file claims under a common TIN. This approach has been used in other work by some of us and others (Federal Trade Commission 2011; Welch et al. 2013; Baker et al. 2014; Clemens and Gottlieb 2017). Physicians who use the same tax ID are part of the same financially-integrated organization. Many financially-integrated organizations use the same tax ID for all physicians in their organization, though it is permissible for the same organization to use multiple tax IDs.

Based on this definition, we calculate at the ZIP code-year level the prevalence of generalist/specialist integration and HHI's of the competitiveness of generalist and specialist physician markets. The models we estimate are of the form:

$$p_{z,t}^{s} = \beta_1 HHI_{z,t-k}^{s} + \beta_2 d_{z,t-k}^{-s} + \beta_3 (d^{-s} \times HHI^{-s})_{z,t-k} + \gamma_z + \delta_s + \theta_t + \varepsilon_{z,t}^{s} \qquad (1')$$

and

$$p_{z,t}^{s} = \beta_1 HHI_{z,t-k}^{s} + \beta_2 d_{z,t-k}^{-s} + \beta_3 (d^{-s} \times HHI^{-s})_{z,t-k} + \beta_4 (d^{-s} \times HHI^{s})_{z,t-k} + \gamma_z + \delta_s + \theta_t + \varepsilon_{z,t}^{s} \qquad (2')$$

where z = (1,...Z), and p, HHI^s, d^{-s}, and $(d^{-s} \times HHI^{-s})$, $(d^{-s} \times HHI^{s})$ are ZIP-code level (weighted) averages constructed as described below.

Intuitively, this specification measures at the area level the effect of the competitiveness of a specialist's market, the prevalence of integration into multispecialty practice, and the incremental effect of integration in areas where the integrated physicians practice with complementary specialties who have market power. If all of the practices serving patients in one ZIP are multispecialty, so $d^{-s} = 1$,

[2] For example, physicians in large group and staff model HMOs are not included in either HCCI or traditional Medicare data.

variations in HHI^{-s} are relevant for all prices in the ZIP. If in another ZIP, half of the practices are multispecialty, so $d^{-s} = 0.5$, then the effects of HHI^{-s} only affect half of the prices in the price index.

3.1. Calculating the price index

We focus on prices paid for office visits with new patients (Current Procedural Terminology [CPT] codes 99201-99205) and established patients (CPT codes 99211-99215). These 10 codes are the most commonly-billed in the United States, and unlike other procedures, represent a service that is common to all specialties. Codes 99201-99205 include all office visits for new patients not previously seen by the physician. These 5 services are intended to span the range of intensity across office visits from 99201, a "basic" office visit with minimal patient complexity and short duration, to 99205, an "advanced" office visit with a high degree of complexity and a long duration. The range 99211-99215 similarly captures the range of office visits for established patients who have been previously seen by the physician.

To construct our ZIP-code level price index, we began by extracting from the HCCI database claims for office visits provided by physicians who reported on the claim that their specialty is family practice/general practice or internal medicine (for generalist physicians), and neurology, gastroenterology, hematology/oncology, urology, general surgery, otolaryngology, cardiology, dermatology, endocrinology, and orthopedics (for specialist physicians).[3] We included only fee-for-service claims from health plans identified as a commercial PPO, EPO, POS, or HMO plan, where the claim was for a single service, the place of service was specified as a physician office, the claim was for

[3] These specialties are the ten largest in the HCCI data excluding pediatrics and obstetrics/gynecology, since these two specialties are not well represented in Medicare claims data and therefore without valid measures of market concentration. We expand our definition of specialties to a larger group of 21 (including psychiatry, cardiology, dermatology, endocrinology, gastroenterology, neurology, rheumatology, pulmonary disease, nephrology, general surgery, ophthalmology, otolaryngology, orthopedics, urology, plastic surgery, infectious disease, vascular surgery, neurosurgery, oncology, allergy/immunology, and radiation oncology) in sensitivity analyses below.

professional (as opposed to facility) fees, the CPT modifier code was either blank or had the value 25,[4] and the claim reported the practice ZIP code of the physician providing the service.

For each claim, we obtain the allowed amount, which is the amount the plan agreed to pay the physician for the service after the application of contractual discount provisions and other plan rules. We refer to this as the "price" for the service. The physician may have received this partly from the insurer and partly from the patient in the form of applicable copayments, coinsurance, or deductibles. We retained for analysis claims that had a positive allowed amount. We excluded claims when there appeared to be a billing error.[5] Separately for each CPT code each year, we dropped as outliers claims where the allowed amount fell in the top 1% or bottom 1% of claims for the code.

We matched the claims to HCCI enrollment data to obtain information about the age, gender, and residence ZIP code of the patient. We retained claims where this information was nonmissing,[6] the patient was age 0-64, and where the enrollment data indicated that the patient was enrolled in commercial insurance and not also enrolled in Medicare. We also obtained the Medicare Geographic Practice Cost Index (GPCI) for work, practice expenses, and malpractice, by ZIP code by year, matched this to the claims based on physician practice ZIP code, and dropped the small number of cases where GPCIs could not be matched to the listed physician ZIP. This resulted in a base of approximately 181 million claims for generalist physicians and 94 million claims for specialists, with characteristics shown in Table 1.

We then estimate the following regression separately for each specialty and year:

$$\ln\left(p_{k,i,z,u}\right) = \beta_0 + \beta_1 AGE_i + \beta_2 SEX_i + \beta_3 PLAN_i + \beta_4 (PROC_i \times MOD_i) + \beta_5 GPCI_u + \gamma_z + \varepsilon_{k,i,z,u} \quad (3)$$

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[4] Modifier code 25 indicates a claim for an identifiable and payable service that is provided on the same day as another treatment and that, without the modifier, would not be paid.
[5] Specifically, we dropped claims when there was another claim for the same service on the same day with a matching negative payment amount.
[6] The HCCI data only report patient ZIP code for ZIP codes with populations of 1,350 or greater, so all observations from ZIP codes smaller than this are excluded from the analysis.

where $p_{k,i,z,u}$ is the price paid for claim *k* for patient *i* resident in ZIP code *z* by a provider in ZIP code *u*. *AGE* is a vector of dummy variables for patient age in 6 categories (0-17, 18-24, 25-34, 35-44, 45-54, 55-64); *SEX* is a dummy variable for patient sex; *PLAN* is a vector of controls for plan type (HMO, POS, EPO, PPO); PROC×MOD is a set of interactions between procedure and modifier codes; GPCI is a vector of the three GPCIs for work, practice expenses, and malpractice; and γ is a vector of fixed effects for ZIP codes.[7] The estimates of the ZIP fixed effects γ for each ZIP code-specialty-year define our adjusted ZIP code level price index $p_{z,t}^{s}$.

3.2. Calculating market characteristics

Our analytic approach follows that in Baker et al. (2014), which adapts the approach of Kessler and McClellan (2000) to the case of physician practices. Using Medicare data as described above, we calculate ZIP-code level market characteristics in three steps. In the first step, we construct an HHI for each ZIP code-specialty-year equal to the sum of squared market shares of billed charges *C* for each practice serving the ZIP code:

$$ZIPHHI_{z,t}^{s} = \sum_{\substack{practices\ j \\ serving\ ZIP\ z}} \left[\frac{C_{j,z,t}^{s}}{\sum_{\substack{practices\ j \\ serving\ zip\ z}} C_{j,z,t}^{s}} \right]^2$$

These ZIP HHIs do not impose any a priori market size; they are instead based on the set of physicians who actually provide services to patients in each ZIP code. We exclude from this calculation claims where the physician is more than 100 miles from the patient ZIP, to reduce the potential for bias from cases where a patient, perhaps while traveling, sees a distant physician who does not play a substantial role in competition for patients residing in the ZIP code.

[7] For sensitivity testing, we also estimated an alternative price index using a version of (3) that excludes the PLAN and PROC×MOD variables.

Using this measure of concentration directly would assume that physician practices differentiate among patients based on the competitiveness of their ZIP code of residence. More realistically, physician pricing decisions would depend on the total demand for services from the practice's core market area. Thus we take a second step to construct practice-level market characteristics with this feature. In order to do this, we identified for each practice *j* a market area equal to the nearest set of patient ZIP codes served by the practice that accounted for 75% of the practice's billed charges.[8] We averaged the patient ZIP code HHIs for the ZIP codes in the market area, weighting by the charges incurred by patients from that ZIP at the practice-specialty-year:

$$HHI_{j,t}^{s} = \sum_{\substack{zips\ z\ in \\ practice\ j\ area}} \left[\frac{C_{j,z,t}^{s}}{\sum_{\substack{zips\ z\ in \\ practice\ j\ area}} C_{j,z,t}^{s}} \right] \times ZIPHHI_{z,t}^{s}$$

This step yields values of HHI^{s} for each practice-year. We define our measure of HHI^{-s} in two ways: $HHIMAX^{-s}$ is the maximum HHI among other specialties present in the practice and $HHIMEAN^{-s}$ is the mean HHI across other specialties present in the practice. (*HHIMAX* and *HHIMEAN* are missing for practices in which no other specialties present).

The third and final step in our analysis is to construct patient-ZIP-code-area market characteristics equal to the average practice-level HHI across the practices serving the ZIP code, weighted by the share of office visits *V* at the practice experienced by patients resident in the ZIP code:

$$HHI_{z,t}^{s} = \sum_{\substack{practices\ j \\ serving\ ZIP\ z}} \left[\frac{V_{j,z,t}^{s}}{\sum_{\substack{practices\ j \\ serving\ zip\ z}} V_{j,z,t}^{s}} \right] \times HHI_{j,t}^{s}$$

We weighted practice-level HHIs in this calculation by visits rather than billed charges so that the aggregation of practice HHIs was similar to the aggregation implicit in the computation of the patient

[8] We imposed the 75%-billed-charge limitation (which was not used in Kessler and McClellan (2000)) to account for the analysis and recommendations in Federal Trade Commission (2011). The limitation was explicitly designed to increase the weight on patient residential areas from which the practice draws most of its patients and hence are most influential in determining the practice's pricing strategy.

ZIP-code level price indices from the HCCI data. We calculate d^{-s} – our key measure of integration -- as the share of practices serving patients in a ZIP code in which another specialty is present, weighted by the number of office visits by ZIP-code residents to physicians of specialty *s* in each practice:

$$d_{z,t}^{-s} = \sum_{\substack{practices\ j \\ serving\ ZIP\ z}} \left[\frac{V_{j,z,t}^{s}}{\sum_{\substack{practices\ j \\ serving\ zip\ z}} V_{j,z,t}^{s}} \right] \times d_{j,t}^{-s}$$

We similarly computed the ZIP-code level weighted average of ($d^{-s} \times HHI^{-s}$) and ($d^{-s} \times HHI^{s}$) over practices serving patients resident in the ZIP code with non-missing values for HHI^{-s} and HHI^{s}:

$$(d^{-s} \times HHI^{-s})_{z,t} = \sum_{\substack{practices\ j \\ serving\ ZIP\ z}} \left[\frac{V_{j,z,t}^{s}}{\sum_{\substack{practices\ j \\ serving\ zip\ z}} V_{j,z,t}^{s}} \right] \times d_{j,t}^{-s} \times HHI_{j,t}^{-s}$$

3.3. Sample Construction

To construct our analysis sample, we included ZIP codes for which we could compute both the price index and the area market and practice characteristics. We excluded ZIP codes with price indices in the top 1% or bottom 1% of the distribution. To be included in the analysis sample, we required ZIP codes to have at least 10 HCCI office visit claims underlying the price index and data from at least 20 Medicare beneficiaries underlying the construction of the practice characteristics. We restrict analyses presented to a balanced panel of ZIP codes that meet these criteria in all 5 study years, though analyses using an unbalanced panel produce very similar results.

Tables 2 and 3 report ZIP code level descriptive statistics for the key variables in the generalist (family practice, general practice, and internal medicine) and specialist samples, respectively, for the year 2012. Table 2 is based on 32,194 observations (16,705 for family practice/general practice and 15,489 for internal medicine) covering 17,284 ZIP codes with at least one type of generalist; table 3 is based on 100,836 observations covering 13,552 ZIP codes with at least one type of specialist (with the distribution across the 10 specialties reported in the table). The statistics in the table were calculated by weighting each ZIP code by the number of HCCI claims underlying the price index. The price indices, by construction, are very close to zero (they are not identically zero because of the sample trimming discussed in the paragraph above). The market for generalist physicians is relatively unconcentrated, with a claim-weighted HHI equal to 0.1396. The overall lack of concentration in the market for generalist physician services, however, masks differences across areas; in the least concentrated quartile, the claim-weighted average HHI for generalists is 0.0564, but in the most concentrated quartile, the HHI is almost five times as large at 0.2639. The market for specialists is, not surprisingly, more concentrated (claim weighted HHI = 0.3218), ranging from 0.1329 in the least concentrated quartile to 0.4850 in the most concentrated one.

Consistent with previous descriptive work, integration is relatively common in our sample. On a claim-weighted basis, approximately 40 percent of generalists are integrated with a specialist, and 32 percent of specialists are integrated with a generalist. Integration of specialists with one another is slightly less common (approximately 22 percent on a claim-weighted basis), indicating that multispecialty practices that include a generalist in many cases do not include a full complement of all of the 10 types of specialists we examine. Appendix Tables 1 and 2 report the matrix of correlations among the key independent variables. The tables show that, especially for generalist physicians, integration is strongly positively correlated with the concentration of ownership of practices in the physician's own specialty. For generalist physicians, for example, the correlation between the claim-weighted integration rate and own-specialty HHI is 0.5307. This highlights the importance of controlling for both concentration of ownership and integration in order to assess the independent effect of each on competition and prices.

4. Results

Table 4 presents estimates from equations (1') and (2') for generalist physicians. Table entries are the effect of moving from the mean of the bottom quartile of the listed variable to the mean of the top quartile. All models are based on balanced panels for the years 2008-2012; standard errors were calculated allowing for arbitrary correlation within a ZIP code. Columns (1)-(4) report results from different variants of equation (1'). Column (1) imposes the constraint $\beta_2 = \beta_3 = 0$; we report an estimate from this specification for purposes of comparison to the previous literature. In our data we find that an increase in the HHI from 0.0564 (mean in the bottom quartile, table 2) to 0.2639 (mean in the top quartile) led to an increase in the generalist price index of approximately 3.2 percent. This is comparable to, although slightly smaller than, the effect of generalist physician market concentration on prices found in Baker et al. (2014). Column (2) relaxes the constraint that $\beta_2 = 0$, i.e., allows own-specialty concentration and integration to have separate effects. Integration with a specialist has a large and statistically significant positive effect on generalist prices. Moving a generalist from a relatively unintegrated area (claim-weighted integration rate of 0.1371, table 2) to a relatively integrated one (0.7252) would allow her to increase her prices for a standard office visit by approximately 4.3 percent. This implies a practice-specific effect of integration on generalist prices of 7.3 percent (0.043 / (0.7252 – 0.1371)). Controlling for integration reduces the estimated effect of own-specialty concentration significantly to approximately 1.8 percent for a bottom-to-top-quartile change in HHI, suggesting that a substantial fraction of previous estimates of the effect of own-specialty concentration may have been due to the competitive effects of integration rather than concentration *per se*.

Column (3) estimates the fully-specified version of equation (1'). It shows that the effect on generalist prices of integration with a specialist increase with a standard measure of specialist market power. Moving a generalist from a relatively unintegrated area to a relatively integrated one, when the markets in both areas for the specialists with whom she integrated were highly unconcentrated (HHI =

0), would allow her to increase her prices by approximately 3 percent; allowing the interaction between integration and specialist market power also to increase from the bottom to the top quartile would allow an additional 1.8 percent increase. Unless there is unobserved time-varying heterogeneity across ZIP code-level markets in the determinants of the price of a standard generalist office visit that is somehow correlated with generalist/specialist integration *in concentrated specialist markets*, and not due to anticompetitive behavior, this estimate represents a rejection of the null hypothesis of no anticompetitive effects of multispecialty practice.

Using the information in table 2 this coefficient can be rescaled in a number of ways. For example, moving a generalist from a relatively unintegrated area to a relatively integrated area (change in integration of 0.5881 = 0.7252 – 0.1371) in a monopolized specialist market (max specialist HHI = 1) would allow her to increase prices by an additional 3.3 percent = (0.5881 * (0.0175 / (0.3530 – 0.0369)), relative to the increase that could be obtained in a highly unconcentrated specialist market (max specialist HHI = 0).

Column (4) presents estimates from an extension to (1') that also includes a control for specialist HHI directly. As we explain above, the model underlying (1') implicitly assumes that the competitiveness of the market for specialist physicians does not affect the price of services of generalist physicians, except insofar as those physicians work together in an integrated practice. Indeed, a generalist physician working in a practice without specialists does not have a defined value for HHI^{-s}. To investigate the validity of this assumption, we calculated for each ZIP code the maximum specialist HHI, *not interacted with the integration rate*, and included it as a control variable. If the estimated coefficient on the interaction between specialist HHI and integration represents a true anticompetitive effect, its magnitude should be invariant to the inclusion of a control for the uninteracted maximum specialist HHI. The results in column (4) confirm this hypothesis; the estimated effects of integration and the interaction between integration and specialist HHI are essentially unchanged from those in column (3), and the uninteracted effect of specialist HHI is small and statistically insignificant.

Column (5) presents estimates of equation (2’), which allow the effect of integration to vary both with the generalist’s own HHI and the largest of the HHIs of the specialists in the generalist’s multispeciality practice. The estimates in column (5) show that the positive effect of integration on generalist prices falls off as the market power of the generalist increases. A bottom-to-top quartile change in the interaction between integration and the generalist’s own HHI is of approximately the same magnitude (3 percent) and of opposite sign to the effect of the interaction between integration and the largest of the HHIs of the specialists in the generalist’s multispecialty practice. This finding can be accommodated by each of the four classes of models of anticompetitive effects of integration discussed above, none of which require the effect of integration to vary in any particular way with the competitiveness of the integrating party’s market.

Table 5 presents estimates from equations (1’) and (2’) for specialist physicians, with columns defined analogously to those in Table 4. Table 5 shows that the standardized effect of own-specialty HHI for specialists, approximately 7.8 percent (controlling for the extent of integration with generalist physicians) is around four times larger than the effect of own-specialty HHI for generalists. The relative magnitude of the effect is due to both a larger unit impact of concentration on specialist prices (0.2201 for specialists versus 0.0841 for generalists, not in any table) and a wider interquartile range of specialist market concentration (0.3521 = 0.4850 – 0.1329 for specialists versus 0.2075 = 0.2639 – 0.0564 for generalists, table 2). By contrast, the average effect of integration is very similar between specialists and generalists (compare column (3), table 5 to column (3), table 4). This is consistent with insurers’ benchmarking multispecialty practice prices off of those for single-specialty practices in the same market (e.g., Clemens and Gottlieb 2017).

Analogous to Table 4, column (4) presents estimates from an extension to (1') that also includes a control for generalist HHI directly. The results in column (3) are not due to the concentration of the market for generalists *per se* or one of its correlates, and generalist concentration has a small and statistically insignificant effect independent of its interaction with integration. Column (5) presents estimates of equation (2') for specialists, showing that as with generalists, the effect of integration declines with the market power of the specialist's own practice.

Table 6 presents estimates of equations (1') and (2') based exclusively on specialist physicians. In these models, instead of specialty *s* = (generalist, specialist), we define specialty *s* = (specialist of type *s*, specialist of type -*s*). These models therefore identify the effect on specialist prices of integration among specialists of different types rather than the effect of integration with a generalist physician. Columns (1) and (2) show that integration with another specialist leads to higher specialist prices, of similar magnitude to integration with a generalist (compare to table 5, columns (2) and (3)). Column (3) of table 6 presents estimates that include a control for other-specialist HHI uninteracted with integration as well as the interacted effect. In contrast to estimates from models of the effect of specialist/generalist integration, the magnitude of the estimated coefficient on the interaction between other-specialist HHI and specialist/other-specialist integration becomes small and statistically insignificant when the uninteracted other-specialist HHI is included in the model. Thus, for specialists in aggregate, we do not find strong support for the hypothesis that integration with another specialist has anticompetitive effects.

To investigate further the effects of competition and integration on specialist prices, table 7 examines the two specialties with the broadest geographic coverage (table 3): cardiology and orthopedics. In both cardiology and orthopedics, the price of a standard office visit is responsive to both the specialty's own HHI and to integration with a generalist physician (columns (1)-(2)), although the effect of both own-specialty concentration and integration is much larger for cardiology than for orthopedics.   As in our analysis of all specialists together (table 5), the estimated effects of integration and the interaction between integration and generalist HHI are invariant to the inclusion of a control for generalist HHI uninteracted, and generalist concentration has a small and statistically insignificant effect independent of its interaction with integration on price (table 7, column (3))).

Columns (4) – (6) of Table 7 replicate the analysis of all specialists together (table 6) for cardiology and orthopedics individually. Columns (4) – (5) show that integration with another specialist leads to higher specialist prices for both cardiology and orthopedics, but especially for cardiology. These results are consistent with those reported for all specialists together in table 6. However, for cardiology and orthopedics, the estimated effects of integration and the interaction between integration and other-specialist HHI are invariant to the inclusion of a control for other-specialist HHI uninteracted (although for cardiologists, other-specialist HHI has a statistically significant negative effect on price). For cardiology and orthopedics, we therefore do find strong support for the hypothesis that integration with another specialist has anticompetitive effects.

Table 8 presents results from variants of equation (1’) that explore the robustness of our results to four of our key modeling choices. In no case do the results change materially, indicating that our findings are not sensitive to the particular specifications or variable definitions that we used. Columns (1) and (2) of table 8 replicate column (2) of tables 4 and 5, respectively, but use as a dependent variable a price index constructed without controls for plan type, procedure, or modifier codes (i.e., imposing the constraint $\beta_3 = \beta_4 = 0$ on equation (3)). Estimates of the effect of concentration and integration based on this alternative price index are similar to those using our standard price index (although the effect of own-specialty HHI is higher for generalist physicians). Columns (3) and (4) also replicate column (2) of tables 4 and 5, but use a simple one-year lag structure for the control variables instead of a 3-year moving average; the magnitude of our estimated effects decline uniformly by a small amount, suggesting that the 3-year moving average captures the market conditions affecting price with slightly greater accuracy. Columns (5) and (6) replicate column (3) of tables 4 and 5, substituting the average HHI of the complementary physicians instead of the largest of the HHIs of the complementary physicians. The use of the mean rather than the max HHI leads to small increases in the base effect of integration and small declines in the magnitude of the interaction between integration and the complementary physician's market concentration. Columns (7) and (8) replicate column (2) of tables 4 and 5, but including ZIP-code level controls for inpatient hospital market conditions and the extent of hospital/physician integration used in Baker, Bundorf, and Kessler (2014); the magnitude and significance of our estimates remain unchanged.

5. Conclusion

The consequences of vertical integration for the competitiveness of markets for health services have been the topic of considerable debate. On one hand, there is almost universal agreement that fragmentation among providers of complementary health services has negative consequences for productive efficiency. On the other hand, a wide range of economic models indicate that vertical integration can be anticompetitive, and recent work has found empirical evidence that supports the hypothesis that physician/hospital integration enhances provider market power, leading to increased prices. Yet despite the high and increasing prevalence of multispecialty physician practices – which raise exactly the same possibilities for pro- and anticompetitive effects in theory – no empirical work has examined how vertical integration among physicians affect prices.

In this paper, we estimate the extent to which changes in multispeciality practice from 2008-2012 in approximately 17,000 urban US ZIP codes affect the price of a standard office visit with a generalist and specialist physician. We obtain data on prices from the Health Care Cost Institute (HCCI) on approximately 40 million individuals from all 50 states, accounting for 27% of the nonelderly insured population, making it one of the largest sources of health insurance claims data ever assembled. We match ZIP-code level price indices from the HCCI data to measures of the characteristics of physician practices and physician markets based on Medicare Part B claims, grouping together physicians based on their receipt of payments under a common Taxpayer Identification Number (TIN). This approach has been used extensively in previous work, because physicians who receive payment under a common TIN are generally part of the same financially-integrated organization. We estimate the effect on generalist physician prices of integration with a specialist and the effect on specialist physician prices of integration with a generalist or another specialist of a different type. Our empirical models control for the competitiveness of the market for generalist and specialist physician services; patient characteristics; the procedure-code mix of office visits; the cost of medical care; the mix of patient age, gender, and plan types; and area- and time- fixed effects.

We report three key findings. First, generalist physicians charge higher prices when integrated with a specialist, holding constant the factors above. The effect of integration with a specialist on generalist prices is approximately twice as large as the effect of the generalist's own market characteristics. Moving a generalist from a relatively unintegrated area (the average ZIP code in the bottom quartile of integration) to a relatively integrated one (the average in the top quartile) would allow her to increase her prices for a standard office visit by approximately 4.3 percent. By comparison, moving a general from a relatively competitive area (the average ZIP code in the bottom quartile of concentration, as measured by the generalist's Hirschman-Herfindahl index) to a relatively uncompetitive area (the average in the top quartile) would allow her to increase her prices by approximately 1.8 percent. We find the same thing in the reciprocal setting – specialist prices are higher when they are integrated with generalists, although the effect on specialist prices of integration with a generalist is not as large, relative to the magnitude of the effect of the specialist's own market characteristics. Because integration and own-market concentration are highly positively correlated, our result shows that a substantial fraction of previous estimates of the effect of own-specialty concentration may have been due to the competitive effects of integration rather than concentration *per se*.

Second, the effect on generalist physician prices of integration with a specialist is larger in uncompetitive specialist markets (and the effect on specialist physician prices of integration with a generalist is larger in uncompetitive generalist markets). The presence of a positive interaction effect between integration and the concentration of the market of the complementary physician is important for two reasons. First, it is a consequence of all of the economic models that predict an anticompetitive effect of vertical integration. Second, it is inconsistent with the hypothesis that the positive correlation between integration and price is due to a simple difference in quality between single- and multispeciality group services. To explain the positive interaction effect, the unobserved quality of a generalist office visit in a multispecialty practice would have to be *increasing* in the extent of specialist market concentration. Of course, as with any observational analysis, we cannot definitively rule out the possibility of unobservables, but this test – along with other validity checks we discuss above – make such explanations for our results implausible.

Third, for specialists in aggregate, we do not find strong support for the hypothesis that integration with another specialist has anticompetitive effects. Our estimate of the effect on specialist prices in aggregate of the interaction effect above (i.e., integration with another specialist × the concentration of the other specialist's market) is sensitive to specification choices, so we cannot rule out the possibility that the observed effect on specialist prices due to multispecialty practice is due to greater unobserved quality. However, we can rule out the possibility that the positive effect of integration with another specialist on price is due to unobserved quality for the two specialties with the broadest geographic coverage – cardiology and orthopedics. For these specialties, our estimate of the interaction effect of interest is robust, similar to the estimates from models of generalist/specialist integration. Investigation of the difference between cardiology and orthopedics and the others in our data is a topic for future research.

Our findings cannot be explained by models in which physicians join multispecialty practices in order to make or receive hidden payments for referrals. Models of hidden kickbacks can explain why referring physicians' unit prices increase in response to integration into a multispecialty practice. Such models can even explain the positive interaction between integration and specialist market power, if specialists with market power valued referrals more than specialists without it. But they cannot explain why multispecialty practice is associated with increases in the prices of both generalists and specialists, along with positive interaction effects both between integration and specialist market power on generalist prices and between integration and generalist market power on specialist prices. Nor can our findings be explained by models in which multispecialty practice enhances productive efficiency, reduces double marginalization, or facilitates welfare-enhancing price discrimination. Thus, we conclude that multispecialty practice has anticompetitive effects.

However, our analysis has several important limitations. First, our measure of competitiveness (the HHI) is not directly derived from a theoretical model of physician/insurer bargaining, despite the fact that this is process through which the prices we study are determined. Although it is used extensively, the limitations of the HHI as a measure of competitiveness or market power are well-known (Bresnahan 1989). Second, although we used numerous strategies in order to minimize the possibility that our results were due to unobserved differences across geographic areas – including controls for area-fixed-effects, patient characteristics, and other related market factors; the choice of a standardized service (a simple office visit) that is relatively comparable across specialties, areas, and over time; and a hypothesis test that rules out at least simple differences in unobserved quality between single- and multispecialty practices – our analysis is fundamentally observational in nature and so cannot definitively exclude that our findings are due to the endogeneity of the integration decision, other aspects of physician markets, or unobserved quality more broadly. Third, we do not assess the consequences of multispecialty practice for social or consumer welfare in aggregate. Our analysis is limited to standard office visits only (for the reasons discussed above), but physicians provide many more specialized services that we do not consider. Exploration of the relevance of these limitations is a topic for future research.

References

Baker LC, Bundorf MK, Kessler DP, Vertical Integration: Hospital Ownership of Physician Practices Is Associated With Higher Prices and Spending, Health Affairs 2014;33(5):756-63.

Baker LC, Bundorf MK, Royalty AB, Levin Z, Physician Practice Competition and Prices Paid by Private Insurers for Office Visits, JAMA 2014;213(16)1653-62.

Bresnahan TF, Empirical Studies of Industries with Market Power, in Schmalensee R and Willig RD, eds. Handbook of Industrial Organization, Amsterdam: Elsevier 1989: 1011-57.

Bresnahan TF and Levin J, Vertical Integration and Market Struction, in Gibbons R and Roberts DJ, Handbook of Organizational Economics, Amsterdam: Elsevier 2012.

Burns LR, Goldsmith JC, Sen A, Horizontal and Vertical Integration of Physicians: A Tale of Two Tails, Advances in Health Care Management 2013;15:39-119.

Capps C, Dranove D, Ody C, The Effect of Hospital Acquisitions of Physician Practices on Prices and Spending, Institute for Policy Research, Northwestern University Working Paper WP-15-02.

Clemens J and Gottlieb JD, In the Shadow of a Giant: Medicare's Influence on Private Physician Payments, Journal of Political Economy 2017;125(1):1-39.

Cooper Z, Craig SV, Gaynor M, Van Reenen J, The Price Ain't Right? Hospital Prices and Health Spending on the Privately Insured, NBER working paper 21815 (2015), available at http://www.nber.org/papers/w21815.

FTC and US Department of Justice, Antitrust Division, Statement of Antitrust Enforcement Policy Regarding Accountable Care Organizations Participating in the Medicare Shared Savings Program, Federal Register October 28, 2011;76(209):67026-32,67029.

Neprash HT, Chernew ME, Hicks AL, Gibson T, McWilliams M, Association of Financial Integration Between Physicians and Hospitals With Commercial Health Care Prices, JAMA Internal Medicine 2015;175(12):1932-9.

Joskow PL, Vertical Integration, in Menard C and Shirley M, eds., Handbook of New Institutional Economics 2005, Springer.

Kessler DP, McClellan MB, Is Hospital Competition Socially Wasteful? Quarterly Journal of Economics 2000;115:577-615.

Pauly MV, The Ethics and Economics of Fee-Splitting, Bell Journal of Economics 1979;10(1):344-52.

Perry MK, Vertical Integration: Determinants and Effects, in Schmalensee R and Willig RD, eds. Handbook of Industrial Organization, Amsterdam: Elsevier 1989: 183-255.

Peters CT, Bargaining Power and the Effects of Joint Negotiation: The "Recapture Effect," U.S. Department of Justice, Economic Analysis Group Working Paper 14-3 (2014).

Spengler JJ, Vertical Integration and Antitrust Policy, Journal of Political Economy 1950;58:347-52.

Welch WP, Cuellar AE, Stearns SC, Bindman AB, Proportion of Physicians in Large Group Practices Continued to Grown in 2099-11, Health Affaris 2013;32(9):1659-66.

Whinston M, Lectures on Antitrust Economics, Cambridge: MIT Press, 2006.

Table 1: Characteristics of HCCI Physician Claims Used in Analysis

	FP/GP/IM	Specialists
Patient age		
0-17	0.0822	0.1288
18-24	0.0703	0.0600
25-34	0.1456	0.1062
35-44	0.2049	0.1637
45-54	0.2575	0.2475
55-64	0.2395	0.2938
Gender		
Female	0.5782	0.5595
Plan Type		
HMO	0.1215	0.1285
POS	0.6494	0.6517
EPO	0.0790	0.0754
PPO	0.1502	0.1374
Procedure code		
99201	0.0014	0.0059
99202	0.0163	0.0461
99203	0.0401	0.1072
99204	0.0220	0.0413
99205	0.0061	0.0097
99211	0.0159	0.0155
99212	0.0402	0.0983
99213	0.5139	0.4002
99214	0.3163	0.2383
99215	0.0278	0.0374
Modifier codes		
None	0.9238	0.8776
25	0.0762	0.1224
GPCI		
Work	1.0136	1.0169
Practice Expense	1.0181	1.0411
Malpractice	1.0341	1.1122
Year		
2008	0.2078	0.1902
2009	0.2147	0.2008
2010	0.1987	0.2027
2011	0.1923	0.2032
2012	0.1865	0.2031
Number of claims	180,652,033	93,790,666

Note: FP = family practice, GP = general practice, IM = internal medicine. Table entries are shares except for GPCI indices.

Table 2: Descriptive Statistics For Key Variables
Markets for Family Practice, General Practice, and Internal Medicine Physician Services

	Mean	Standard deviation	Mean in bottom quartile	Mean in top quartile
Price index	0.0034	0.1725	-0.1932	0.2358
Own-specialty HHI	0.1396	0.0912	0.0564	0.2639
Integration with specialist	0.4034	0.2290	0.1371	0.7252
Integration with specialist*max(spec HHI)	0.1600	0.1360	0.0369	0.3530
Integration with specialist* own HHI	0.0723	0.0836	0.0121	0.1842

Note: Specialists are listed in Table 3.

Table 3: Descriptive Statistics for Key Variables
Markets for Specialist Physician Services

	Mean	Standard deviation	Mean in bottom quartile	Mean in top quartile
Price index	-0.0028	0.1562	-0.1828	0.2078
Own-specialty HHI	0.2753	0.1488	0.1329	0.4850
Integration with FP/GP/IM	0.3218	0.2735	0.0449	0.7280
Integration with FP/GP/IM * max(FP/GP/IM HHI)	0.0492	0.0650	0.0049	0.1329
Integration with other specialist	0.2214	0.2189	0.0302	0.5396
Integration with other specialist*max(HHI oth spec)	0.0826	0.1041	0.0092	0.2205
Integration with FP/GP/IM * own HHI	0.1037	0.1367	0.0091	0.2902
Integration with other specialist* own HHI	0.0695	0.1074	0.0063	0.2018

	share of claims	# of zips covered
neurology	0.0544	8542
gastroenterology	0.0699	9150
hematology/oncology	0.0602	7699
urology	0.0619	9622
general surgery	0.0475	8956
otolaryngology (ENT)	0.0865	8698
cardiology	0.0941	11695
dermatology	0.2645	11183
endocrinology	0.0434	4853
orthopedics	0.2177	12018

Note: FP = family practice; GP = general practice; IM = internal medicine.

Table 4: Effect of Competition and Integration with Specialist Physicians on Prices of Family Practice, General Practice, and Internal Medicine Physician Services

	(1)	(2)	(3)	(4)	(5)
Own-specialty HHI	0.0317	0.0175	0.0149	0.0149	0.0342
	(0.0021)	(0.0021)	(0.0022)	(0.0022)	(0.0032)
Integration with specialist		0.0428	0.0298	0.0299	0.0421
		(0.0021)	(0.0037)	(0.0037)	(0.0029)
Integration with specialist*max(spec HHI)			0.0181	0.0178	0.0301
			(0.0040)	(0.0039)	(0.0043)
Integration with specialist* own HHI					-0.0334
					(0.0038)
Max(specialist HHI)				0.0034	
				(0.0028)	
N	160970	160970	160970	160970	160970
number of zip codes	17284	17284	17284	17284	17284

Note: 2008-12. All models include time and zip code fixed effects. Pooled model includes fixed effect for internal medicine. Standard errors clustered at the zip code level. Table entries are the effect of moving from the mean of the bottom quartile of the listed variable to the mean of the top quartile.

Table 5: Effect of Competition and Integration with Family Practice, General Practice, and Internal Medicine Physicians On Prices of Specialist Physician Services

	(1)	(2)	(3)	(4)	(5)
own-specialty HHI	0.0862	0.0775	0.0771	0.0771	0.0840
	(0.0018)	(0.0018)	(0.0018)	(0.0018)	(0.0020)
integration with FP/GP/IM		0.0371	0.0217	0.0216	0.0341
		(0.0014)	(0.0021)	(0.0021)	(0.0025)
integration with FP/GP/IM *			0.0187	0.0188	0.0234
max(FP/GP/IM HHI)			(0.0018)	(0.0019)	(0.0020)
integration with FP/GP/IM *					-0.0168
own HHI					(0.0024)
Max(FP/GP/IM HHI)				-0.0015	
				(0.0030)	
N	504180	504180	504180	504180	504180
number of zip codes	13552	13552	13552	13552	13552

Note: 2008-12. All models include time, zip code, and specialty fixed effects. Specialists are listed in Table 3. Standard errors clustered at the zip code level. Table entries are the effect of moving from the mean of the bottom quartile of the listed variable to the mean of the top quartile.

Table 6: Effect of Competition and Integration with Other Specialist Physicians On Prices of Specialist Physician Services

	(1)	(2)	(3)
own-specialty HHI	0.0823	0.0829	0.0822
	(0.0018)	(0.0018)	(0.0018)
integration with other	0.0406	0.0226	0.0228
specialist	(0.0012)	(0.0023)	(0.0023)
integration with other specialist*max(oth spec		0.0207	-0.0036
HHI)		(0.0026)	(0.0032)
Max(oth spec HHI)			0.0262
			(0.0023)
N	504180	504180	504180
number of zip codes	13552	13552	13552

Table 7: Effect of Competition and Integration on Prices of Cardiology and Orthopedic Physician Services

	cardiology						orthopedics					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
own-specialty HHI	0.0996	0.0816	0.0814	0.0863	0.0798	0.0797	0.0473	0.0453	0.0453	0.0482	0.0438	0.0437
	(0.0079)	(0.0079)	(0.0079)	(0.0076)	(0.0076)	(0.0076)	(0.0056)	(0.0057)	(0.0057)	(0.0056)	(0.0057)	(0.0056)
integration with FP/GP/IM	0.0403	0.0122	0.0115				0.0129	0.0025	0.0020			
	(0.0046)	(0.0062)	(0.0064)				(0.0028)	(0.0043)	(0.0045)			
integration with FP/GP/IM * max(FP/GP/IM HHI)		0.0489	0.0502					0.0138	0.0145			
		(0.0065)	(0.0069)					(0.0045)	(0.0047)			
integration with other specialist				0.0809	0.0376	0.0343				0.0116	-0.0126	-0.0124
				(0.0055)	(0.0104)	(0.0102)				(0.0029)	(0.0046)	(0.0046)
integration with other specialist*max(HHI oth spec)					0.0530	0.0561					0.0300	0.0298
					(0.0101)	(0.0099)					(0.0059)	(0.0058)
Max(FP/GP/IM HHI)			-0.0043						-0.0019			
			(0.0068)						(0.0050)			
Max(oth spec HHI)						-0.0213						0.0017
						(0.0056)						(0.0035)
N	58475	58475	58475	58475	58475	58475	60090	60090	60090	60090	60090	60090
number of zip codes	11695	11695	11695	11695	11695	11695	12018	12018	12018	12018	12018	12018

Note: 2008-12. All models include time and zip code fixed effects. Specialists are listed in Table 3. Standard errors clustered at the zip code level. Table entries are the effect of moving from the mean of the bottom quartile of the listed variable to the mean of the top quartile.

Table 8: Effect of Competition and Integration on Prices of Physician Services, Alternative Models

	Price index adjusted for patient age/sex only		Simple one-year lag structure for regressors		Use Mean HHI Not Max HHI		Control for hospital HHI & hospital/physician integration	
	FP/GP/IM (1)	specialists (2)	FP/GP/IM (3)	specialists (4)	FP/GP/IM (5)	specialists (6)	FP/GP/IM (7)	specialists (8)
own-specialty HHI	0.0314	0.0737	0.0157	0.0723	0.0165	0.0769	0.0167	0.0776
	(0.0028)	(0.0022)	(0.0019)	(0.0017)	(0.0022)	(0.0018)	(0.0021)	(0.0018)
integration with FP/GP/IM		0.0370		0.0320		0.0234		0.0372
		(0.0017)		(0.0012)		(0.0021)		(0.0014)
integration with FP/GP/IM * mean(FP/GP/IM HHI)						0.0163		
						(0.0018)		
integration with specialist	0.0383		0.0337		0.0351		0.0428	
	(0.0027)		(0.0017)		(0.0043)		(0.0021)	
integration with specialist*mean(spec HHI)					0.0100			
					(0.0048)			
N	160970	504180	160970	504180	160970	504180	152990	453200
number of zip codes	17284	13552	17284	13552	17284	13552	16311	13050

Appendix Table 1: Correlations Among Key Independent Variables
Markets for Family Practice, General Practice, and Internal Medicine Physician Services

	own-specialty HHI	integration with specialist	integration with specialist*max(spec HHI)	integration with specialist* own HHI
own-specialty HHI	1.0000			
integration with specialist	0.5307	1.0000		
integration with specialist*max(spec HHI)	0.7216	0.8714	1.0000	
integration with specialist* own HHI	0.8500	0.7964	0.8965	1.0000

Note: Specialists are listed in Table 3.

Appendix Table 2: Correlations Among Key Independent Variables
Markets for Specialist Physician Services

	own-specialty HHI	integration with FP/GP/IM	Integration with FP/GP/IM* max(FP/GP/IM HHI)	Integration with other specialist	integration with other specialist *max(HHI oth spec)	integration with FP/GP/IM* own HHI	integration with other specialist* own HHI
own-specialty HHI	1						
integration with FP/GP/IM	0.3111	1					
integration with FP/GP/IM * max(FP/GP/IM HHI)	0.3929	0.7449	1				
integration with other specialist	0.2370	0.6172	0.6443	1			
integration with other specialist*max(HHI oth spec)	0.3095	0.5829	0.7851	0.8833	1		
integration with FP/GP/IM * own HHI	0.6270	0.8444	0.7448	0.5328	0.5628	1	
integration with other specialist* own HHI	0.4936	0.5515	0.6551	0.8712	0.8400	0.6800	1

Note: FP = family practice; GP = general practice; IM = internal medicine. Specialists are listed in Table 3.