

Do Physicians Possess Market Power?*

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Abstract

We study the degree to which greater physician concentration leads to higher service prices charged by physicians in the commercially insured medical-care market. Using a database of physicians throughout the entire United States, we construct physician-firm concentration measures based on market boundaries defined by fixed driving times—we label the “fixed-travel-time HHI” (FTHHI). Similar to the measure constructed by Kessler and McClellan [2000], the FTHHI is constructed to mitigate omitted-variable bias attributable to higher quality physicians attracting a higher share of patients. We link these concentration measures to health insurance claims. We find that physicians in more concentrated markets charge higher service prices. Cross-sectional estimates show that a ten percent increase in concentration is associated with a 0.5 to 1 percent increase in fees. Panel estimates show the effect may be twice as large, although estimates are less precisely estimated. Our estimates imply that physician consolidation has caused about an eight percent increase in fees over the last 20 years.

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1 Introduction

Physicians play a critical role in the health-care market. Acting as the patient’s health-care consultant, as well as the medical service provider, they act on the patient’s behalf to choose medical services.¹ However, physicians also organize themselves into firms and may therefore act as profit-maximizing agents. Specifically, by flexing their bargaining muscle, physician firms may be able to raise the fees they charge to insurance carriers. In this study, we empirically assess the degree to which greater physician market concentration leads to higher physician service prices. These effects are mainly identified through the large variation in service prices observed across markets (Dunn, Shapiro, and Liebman [2012]).

While there has been an extensive line of research regarding hospitals’ ability to leverage their market power into higher fees,² there has been very little research regarding physicians’ bargaining power.³ Examining how physicians’ market power affects prices may be an important step in assessing the cause of overall medical-care spending variation. Numerous studies have documented large increases in overall medical-care expenditures over the last few decades, which now account for more than 17 percent of GDP.⁴ Growth in medical expenditures has been accompanied by a trend toward consolidation across health care providers.⁵ Thus, it is conceivable that long-run trends in consolidation have contributed to the growth in medical-care expenditures. Furthermore, potential concerns have been raised by some industry experts and antitrust authorities that the recent health care reforms enacted in 2010 may accelerate consolidation because they encourage greater cooperation among providers. Both the Federal Trade Commission (FTC) and Department of Justice (DOJ) have taken different views on the potential impact of recent health care reform. The FTC sees consolidation resulting from these reforms as a potential risk that could lead to higher prices, while the DOJ is seen as more receptive to the potential consumer benefits from the proposed reforms.⁶ Understanding how physician market power

¹See, for example, Sirovich, Gallagher, Wennberg, Fisher [2008].

²See Noether [1988], Dranove, Shanley, and White [1993], Lynk [1995], and Keeler, Melnick, and Zwanziger [1999], Town and Vistnes [2001], Capps, Dranove, and Satterthwaite [2003].

³Research regarding physician market competition has primarily focused on identifying whether or not physicians actually possess monopoly power. As explained by Gaynor [1995], most of these studies have aimed to infer the presence of market power by searching for monopoly rents and supra-normal returns on investment to education (Sloan [1970], Leffler and Lindsay [1980], Burstein and Cromwell [1985].

⁴See Aizcorbe and Nestoriak [2011], Chernew, Hirth, and Cutler [2009], Chernew, Baiker, and Hsu [2010], Cutler and Ly [2011], Dunn, Liebman, Pack and Shapiro [2012].

⁵Gaynor and Haas-Wilson [1999], Smart [2006] and Liebhaber [2007].

⁶See Thomas Catan [2011] “This Takeover Battle Pits Bureaucrat vs. Bureaucrat.” *The Wall Street*

affects medical-care spending may give important insights about the potential outcome of this policy reform.

A major reason for the lack of research regarding physician market power has been the dearth of historical granular data covering physician firms. To add fuel to the fire, one must also be able to accurately link physician-firm data to detailed medical-care expenditure information. This study is unique in this regard as we are able to link together a wealth of historical data on physician firms with a comprehensive data set on commercial payments. The physician data are from the SK&A[©] physician database and include information on the firm size, specialty, and specific geographic coordinates of what they claim to be over 95 percent of physician firms in the United States. This highly detailed data enable us to construct precise physician concentration measures. We link these concentration measures with commercial health insurance claims from the MarketScan[®] Research Database from Thomson Reuters. The data include individual patient health claims for several million privately covered individuals covering thousands of procedures and hundreds of diseases and types of health plans across the entire U.S. The sheer size of this data is a bit daunting, but proves to be important for identification purposes because there is an enormous degree of heterogeneity in types of health service providers, procedures, patient ages, diseases, stages of illness, co-morbidities and plan types.⁷ Finally, we link together data from HealthLeaders-Interstudy[©], which provide comprehensive information on enrollment for health insurance firms. This allows us to create concentration measures of insurance firms. To simplify our analysis and computation burden, we limit our analysis to cardiologists and orthopedists. We believe these two specialties provide a comprehensive look at the physician market since these are two of the largest specialities and cover a wide spectrum of physicians.⁸ Cardiologists represent the broad category of internists treating chronic conditions, while orthopedists represent the broad category of surgeons treating more acute conditions.

This paper employs a unique methodology to study competition that is customized

Journal. Other health economists, interest groups, and politicians have raised some concerns that the new health care law may spur additional consolidation and harm consumers (America’s Health Insurance Plans (AHIP) [2011], Berenson, Ginsburg, and Kemper [2010], and “Hearing on Health Care Industry Consolidation” September 2011).

⁷The payment information used to construct prices in this database are the actual negotiated amounts paid to providers and not the “charges” or list price that have been the basis of many prior studies of health care competition.

⁸The Major Practice Categories of “Cardiology” and “Orthopedics & Rheumatology” are the two highest expenditure categories for the commercially insured population (See Aizcorbe and Nestoriak [2011] and Dunn, Liebman, Pack and Shapiro [2012]).

to the features of the physician marketplace and the data sources available in this study. This paper exploits the detailed micro level data to look at the effects of competition on service prices at the patient-disease level. This allows us to control for a multitude of patient characteristics. Second, the precise geographic coordinates of physicians are used to build a consistently defined concentration measure that takes into account the distance and travel time of patients to competing doctors in surrounding areas. We refer to this measure as the “Fixed-Travel-Time Herfindahl-Hirshman Index” (FTHHI). Similar to the measure used in Kessler and McClellan [2000], the FTHHI is based on theoretically predicted market shares. Importantly, the shares are created based solely on information about the size of firms and the distance between the firms and patients. This removes potential contamination attributable to higher quality providers attracting more patients.

To motivate our empirical analysis, we outline a two-period model showing how market-structure is linked to the determination of service prices. An important feature of the model is that the determination of prices depends not only on physician concentration, but also on the concentration of the insurance market. That is, service prices are likely determined by the relative degree of bargaining power between physicians and insurance carriers, not just the level of concentration in the physician market. To control for the insurance side of the market, we include an insurance concentration measure in our regression analysis. As this measure is constructed using actual patient shares, there would likely be endogeneity bias using OLS. We attempt to mitigate this bias by using a battery of instrumental variables strategies.

We find that physician concentration is positively and significantly correlated with service price levels. Specifically, our cross-sectional estimates show that a 10 percent increase in the FTHHI will cause between a 0.5 and 1 percent increase in physician fees. These estimates show that the market size for physician services may be as small as a 20 minute driving-time radius. Even controlling for market specific fixed effects that account for all market specific determinants of price that are common among cardiologists and orthopedists, we find that if cardiologists (orthopedists) are relatively more concentrated than orthopedists (cardiologists) in the same market, they are able to command significantly higher prices. Finally, we estimate a panel regression, where we use only variation in concentration for a given market over time. Estimates are larger, but not as precisely estimated as the cross-sectional estimates. Linking our estimates to historical survey data discussed in Rebitzer and Vortruba [2011] implies that physician consolidation has caused about an 8 percent increase in fees over the last two decades (1988 to 2008).⁹ We also find

⁹Rebitzer and Vortruba [2011] report statistics from a series of physician surveys conducted by the

some evidence that insurance carriers in more concentrated health insurance markets pay lower fees to physicians.

This study is organized as follows. Section 2 describes the physician and insurance market, and details how physician and insurance concentration may determine services prices. Section 3 describes the data in detail as well as explains how service price and concentration measures are constructed. In Section 4, we estimate whether there is a causal relationship between physician concentration and physician services prices using both cross-sectional as well as panel variation. In Section 5, we conclude. In the concluding section, we highlight key limitations of our study and directions for future research to improve on our analysis.

2 Physician and Health Insurance Carrier Organizations

2.1 Physician Organization

The study of physician consolidation has historically been a relatively uninteresting topic due to the fact that a vast majority of physicians worked in solo practices. However, the market for physicians has shifted dramatically over the past few decades. In 1965 only about 10 percent of physicians were in group practices with three or more physicians, but by 1991 group practice physicians accounted for more than 30 percent of all physicians (Smart [2006]). This trend continued through the 1990s and early 2000s. Based on physician surveys, the proportion of physicians in solo practices decreased from 49 percent in 1988 to 33 percent in 2001 (Rebitzer and Vortruba [2011]). There is concern that the recent passage of the health care reforms in 2010 may accelerate the pace of consolidation because the law encourages greater cooperation among providers through the formation of Accountable Care Organizations (ACOs).¹⁰ For instance, a 2011 *New York Times* article by Robert Pear (“Trade Commission Challenges a Hospital Merger”) reports that federal officials are

American Medical Association—the proportion of physicians in solo practice, two to four physicians, five to nine, etc. We calculated two chain-linked series of HHIs based on their survey information as well as the SK&A data—one based on the lower bound of the reported firm size bin and another based on the upper bound. The lower bound estimate implied a growth prices of 8.15 percent and the upper bound implied growth in prices of 8.85 percent.

¹⁰An ACO is a network of providers that share the provision of care to patients. An ACO would normally include both physicians and hospitals and would encourage greater coordination of care among providers through financial incentives.

seeing a wave of mergers, in part because of the incentives built into the new health law.

As physician consolidation grew there emerged wider variation in the type of physician practices. Physician group practices vary in size as well as the degree of specialization. Most group practices consist of physicians of the same specialty (that is, single-specialty groups) but there also exist groups with differing specialties (that is, multi-specialty groups). Physician groups can occur as part of a larger health system that contain other group practices, as well as hospitals (that is, Physician-Hospital Organization [PHO]). More complex forms of horizontal structures may involve group practices clustering with one another for bargaining purposes.¹¹

Although there are a variety of organizational structures, this paper focuses on the horizontal aspects of these organizations where physicians with the same type of specialization are part of the same group or system. This type of horizontal consolidation has clear implications for bargaining and leverage with health insurance plans.¹² The source of the bargaining power rests on the ability of physicians to threaten to exclude its group from an insurance carrier's network, which may cause significant harm to the profitability of the health insurer. For example, an insurance carrier may find it challenging to attract and adequately treat enrollees if it has only a limited number of cardiologists or orthopedists.

2.2 Insurance Carrier Organization

Similar to the physician market, the health insurance market includes a wide variety of types and sizes of firms (that is, health insurance carriers). They can range in size from small local firms to large firms that are national in scope.¹³ Insurance carriers compete with one another to attract enrollees. Three important characteristics that differentiate plans in the eyes of the patient are (1) the size of its provider network, (2) restrictions

¹¹For example, two physician groups may have distinct offices and administrative services, but may contract with insurance carriers for legal bargaining purposes as an independent practice association (IPA). In most states, IPAs represent physicians who only compete for *capitated* HMO contracts. For non-capitated contracts, the physicians must negotiate individually unless the FTC rules that they are "clinically integrated" for efficiency reasons (Berenson, Ginsburg, and Kemper [2009]). (Here we focus on specialists that are less often subject to capitated payments where the IPA market structure is less applicable.) In another example, two physician groups may join forces to share administrative services (e.g. a group practice without walls (GPWW)) as well as contracting.

¹²There have been fewer studies of the effects of consolidation in health care markets along the vertical dimension where the theoretical impact of this type of consolidation is ambiguous (See Cuellar and Gertler [2006] and Ciliberto and Dranove [2006]).

¹³Dranove, Gron, and Mazzeo [2003] show that this type of differentiation can be important in how insurance firms compete.

on the patients' choices and (3) the overall price of its insurance contract. Generally, it is assumed that consumers prefer a large choice of providers, less restrictions, and lower prices.

The overall size of the insurance carrier's network is determined according to the bargaining outcome with providers, which we will discuss in the next subsection. Although most commercial health insurance plans have a network of providers, these network insurance plans differ in the restrictiveness of their network.¹⁴ There is a spectrum of types of plans ranging from the least restrictive PPO plans that often contain a broad network of providers and include out-of-network coverage, to the most restrictive type of plans, health maintenance organizations (HMO). Generally, but not always, HMOs will not cover out-of-network providers and will also require a primary-care physician to act as a gatekeeper for seeing a specialist. Finally, the overall price of the insurance contract usually includes the price of the premium, as well as out-of-pocket payments such as a deductible, a coinsurance payment or a fixed co-payment.

Of course, the insurance carrier would like to increase market share, but it would also like to lower its overall costs, which includes the expenditure of treating an episode of care. There are two primary ways in which an insurance carrier can attempt to control the expenditure of an episode of care. It can (1) attempt to lower payments (that is, fees) made to providers or it can (2) attempt to lower the amount of services per episode of care (that is, service utilization). In this study, we focus on fees which can be bargained over with providers. See Dunn and Shapiro (2012) for analysis on service utilization.

2.3 Physician-Insurance Carrier Bargaining

Both an insurance carrier's and a physician group's bargaining power resides in the ability to credibly exclude the other side from its patient base.¹⁵ Through a simple framework, we show how each side can use this leverage to affect service price. Specifically, the relative level of concentration on each side of the bargaining table can transmit into variations in service prices (that is, physician fees).

To better understand the methodology behind our reduced-form empirical framework, we feel it may help to guide the reader through a more detailed bargaining model. In particular, certain features of the model will be important when thinking about potential

¹⁴According to the Kaiser Health Benefit Survey less than 3 percent of enrollees in the U.S. had a conventional indemnity insurance plan.

¹⁵Staten, Umbeck, and Dunkelberg [1987, 1988] as well as Sorenson [2003] are studies showing that an insurance carrier's bargaining leverage resides in its credibility of exclusion.

instruments for physician and insurance concentration in our estimation strategy discussed in Section 4. We summarize implications of this type of model below, however, we encourage interested readers to see Appendix A for more explicit details.

The model splits the determination of the physician's service price into two distinct periods:

- **Period 0:** Entry of physician and insurance firms.
- **Period 1:** Service price (P) negotiated.

One can think of Period 0 as the time period when the long-run equilibrium entry of insurers and physicians occurs, which determines market structure. In Period 1, the physician and the insurance carrier subsequently bargain over service prices, defined as the price per service paid to the physician by the insurance carrier.

A key feature of period 0 is that there are *distinct* factors that affect physician and insurer entry decisions. Namely, the size of the market facing insurance carrier is distinct from the market facing the physician firm. Physicians tend to operate in relatively local geographic markets and provide physician services to individuals across a wide range of insurance types, including commercial market enrollees, Medicare enrollees, Medicaid enrollees, and individuals enrolled in COBRA. In contrast, health insurance carriers typically offer insurance to employers over a broader geographic area, such as an MSA. These insurance carriers disproportionately serve individuals that are not in the government-funded programs. Insurance carriers also sell their services to a wide variety of employers, which may have an impact on the amount of revenue that they receive and how they operate their business. While larger firms typically offer health insurance to their employees and tend to purchase self insurance, smaller employers are much less likely to offer insurance and they tend to purchase full insurance. In addition, the fixed costs associated with entering a new market are likely very different for physicians and insurance companies since they offer distinct services. This feature is especially important with regards to the strength of potential instruments for physician and insurance concentration.

In Period 1, the service price is negotiated. In this model, the service price (that is, fee schedule) will depend on negotiations between the physician group and the insurance carrier. Although fixed costs and market size affect entry in Period 0, they are sunk and are no longer important in the determination of the service price in Period 1. Therefore, in this bargaining game, the market size and fixed costs do not directly enter this first period profit maximization problem. However, they clearly affect entry in Period 0, which

will subsequently have an impact on this maximization problem and the negotiated price. That is, pricing decisions in the market will be related to market size and fixed costs, *only* through the effects on the competitive environment (See equation 13 of the Appendix). This feature will be important when we discuss the validity of potential instruments for physician and insurance concentration in our estimation strategy in Section 4.1.1.

Although a stylized bargaining model provides some intuition for the determinants of the negotiated service price, there are several reasons why we empirically analyze a reduced-form relationship between the competitive environment and negotiated prices. First, it is compositionally difficult to capture the complexity of the actual bargaining environment. For instance, it is relatively common for bargaining between insurers and providers to break down, so there is no negotiated contract; and the possibility that negotiations may fail, can result in multiple equilibria in the insurer and provider contracting decisions (for example, see Ho [2009]). Therefore, it is not clear what pricing game is appropriate to consider in this market. Second, in this paper we are less interested in identifying the underlying structural parameters and profit functions of insurers and physicians, and more interested in understanding the relationship between the competitive environment and the observed outcomes, as in Davis [2005, 2006a]. Finally, although we are using extremely rich and geographically diverse data, there are strong limitations in the data, as we will describe later, that make a more structural analysis challenging.

We develop an empirical framework where the service price will depend on the relative degree of bargaining power, we label Z , of the physician and the insurance carrier in the market. One possible measurement of Z is the logarithm of the ratio of concentration measures: $Z = \ln\left(\frac{HHI^{phys}}{HHI^{ins}}\right)$, where HHI^{phys} and HHI^{ins} are the degrees of concentration in the physician and insurance carrier markets, respectively. These concentration ratios reflect the strength of the outside options of physicians (when considering contracts with different insurers) and insurers (when considering contracting with different physicians). To examine how service price may depend on Z , we look at two polar market structures:

$$\begin{aligned} Z_1 \approx -\infty &\Rightarrow \text{Competitive Physician, Monopolistic Insurance Carrier.} \\ Z_2 \approx \infty &\Rightarrow \text{Monopolistic Physician, Competitive Insurance Carrier.} \end{aligned}$$

Moving from market structure Z_1 to Z_2 , we are shifting market power leverage from insurance carriers to physicians. Under market structure Z_1 the monopolistic insurance carrier can credibly threaten to keep the competitive physician out of its network. This credible threat will subsequently induce physicians to bid the price of services down to the point where $P = \psi(Q)$, the physician's marginal cost of providing the minimum

amount of services. By contrast, under market structure Z_2 , the monopolistic physician can credibly threaten to exclude the insurance carrier’s patients from using its services. Specifically, provided that the risk-free rate of return is earned, there will always be at least one insurance carrier willing to accept the profit-maximizing monopoly price.¹⁶ Thus, any insurance carrier who wants to contract with this physician must offer the profit maximizing service price.

The actual marketplace is rarely perfectly competitive or completely monopolistic. Instead, prices will be pulled towards either of these two extremes by the side with larger bargaining leverage. Thus, bargaining leverage is manifested in price variations by each side’s ability to credibly exclude the other from its network. It is also important to note that this type of bargaining is usually implicit, rather than direct, interactive bargaining. That is, a health care plan may not directly discuss or haggle with a physician firm over price, but rather just recognize its relative competitive position and create a payment schedule that would entice the physician firm to participate in the plan.

3 Data

In this section, we give a comprehensive overview of the datasets used in this study. First, we describe the MarketScan[®] health claims database, which is a database that tracks claims from all providers using a nationwide convenience sample of patients. We also provide an overview of how we calculated our physician service price measure. Second, we describe the SK&A[©] physician database, which includes information on location, specialty, unique physician identifiers, medical practice group, and health system of physicians in the United States. We then give an overview of the HealthLeaders-InterStudy[©] as well as the Area Resource File data, which provide information used to make concentration measures of health insurance firms as well as demographic information.

3.1 MarketScan[®] Data

The MarketScan[®] database tracks claims from all providers using a nationwide convenience sample of patients. Our collected data span 2005 through 2008. The data include health claims from employers and insurance carriers throughout the entire United States; all claims have been paid and adjudicated. Geographic information is provided, however,

¹⁶That is, the monopoly price will be $P = \frac{\varepsilon}{1-\varepsilon}\psi^{mon}$, where ε is the patient’s demand elasticity and ψ^{mon} is the marginal cost at the monopoly quantity of services.

only about the patient’s county of residence and physician’s county of practice. This paper uses the Commercial Claims and Encounters Database portion of the MarketScan® Databases, which includes health care utilization and cost records at the encounter level. This portion of the database provides patient identifiers that may be used to sum expenditures to the patient-episode level.

The Commercial Claims and Encounters Database contains data from employer and insurance carrier sources concerning medical and drug data for several million employer-sponsored insurance (ESI)-covered individuals, including employees, their spouses, and dependents. Each observation in the data corresponds to a line item in an “explanation of benefits” form; therefore each claim can consist of many services and each encounter can consist of many claims.

Importantly we can differentiate between payments made to physicians from those paid to other providers (for example, hospitals and pharmacies). For instance, suppose a patient is being treated for congestive heart failure in a hospital. The claims data differentiates between types of providers such that payments made to the physician for performing a coronary artery bypass are distinct from those made for hospital operating room expenses. We use MarketScan’s “payment” variable which is defined as the total gross payment to a provider for a specific service. Specifically, this is the amount of dollars eligible for payment after applying pricing guidelines such as fee schedules and discounts, and before applying deductibles and co-payments. MarketScan® also indicates the type of plan the claim was made under, which allows us to ignore episodes in which a capitation payment was made.¹⁷

3.1.1 Creating a Measure of Service Prices

Our calculation of the physician’s services price is based on Dunn, Shapiro, and Liebman [2012]. The service price will be specific to a physician-patient-episode triple, where “episode” refers to treatment for an episode of a specific disease. Defining the observation at this level will allow us to control for a host of patient and disease specific covariates in our estimation.

There is a three-step process in obtaining a measure of service prices. First, we obtain the physician expenditure for a particular episode of care. Second, we quantify the amount of services performed by the physician during the episode of care. Finally, we calculate the service price as defined as the expenditure divided by the quantity of services.

¹⁷Approximately 3 percent of our sample are capitated episodes. These observations are likely to include closed HMO systems such as Kaiser-Permanente patients.

To identify episodes of care for a specific patient with a certain disease, we apply the Medical Episode Grouper[®] (MEG) provided by Thomson Reuters, which assigns a procedure to an episode using information on claims as well as the patient’s medical history. Spending is allocated to a patient between a beginning and an end date by assigning an “episode ID”, n , to each claim in the data.¹⁸ Let Γ_n be the set of procedures used for treating episode n identified by the MEG.

The total expenditures made to the physician for treating episode n is:

$$TE_n = \sum_{j \in \Gamma_n} p_{jn} \tag{1}$$

where p_{jn} is the full payment (including the patient’s out-of-pocket costs) to the physician for procedure j in episode n .¹⁹ Pricing information for a specific procedure is the payment attached to the specific health claim line in the MarketScan[®] data. We identify procedures j at the most granular level possible, based on a specific CPT code, modifier, and “place of service.”²⁰ Note that each episode uniquely identifies an individual patient, k , with disease d , treated by a physician p , in county c , that begins in time period t .²¹ The large advantage of the MEG algorithm is that it allows us to isolate the service mix and total price for treating a particular patient’s illness. However, these algorithms are also considered a “black box” in the sense that they rely entirely on the expertise of those that developed the grouper software.

Next, we calculate the quantity of services per episode of care, referred to as the “service-utilization component” in Dunn, Shapiro, and Liebman [2012]. We measure this variable by the following:

$$Q_n = \sum_{j \in \Gamma_n} r_j \tag{2}$$

where r_j is the average price of procedure j in the entire sample. Here, r_j serves as a proxy for the number of services rendered for each given procedure, and thus one can think of r_j as being comparable to each procedure’s relative value units (RVUs) assigned

¹⁸We isolated episodes where the patient sees the same physician for the entire episode of care, however, results were not sensitive to this exclusion.

¹⁹Note that each episode occurs only once in the data, thus we do not have a panel of episodes.

²⁰We chose to differentiate procedures by place of service based on the fact that Medicare provides higher fees for physicians who have their own office-based facility.

²¹An episode of care may span several time periods (half-years in our analysis) for chronic diseases. We assign the episode to the date at which the episode begins. For our analysis, we isolated episodes treated by only one physician.

Table 1: MarketScan[®] Descriptive Statistics

	Cardiology			Orthopedics		
	Total Sample	2005	2008	Total Sample	2005	2008
Service Price	0.966 (0.299)	0.947 (0.307)	0.973 (0.299)	1.006 (0.270)	0.979 (0.268)	1.017 (0.277)
Patient Age	51.2 (11.1)	51.3 (11.1)	51.2 (11.1)	40.4 (17.8)	40.5 (17.8)	40.5 (17.9)
Patient Gender (% Male)	52.1%	52.3%	51.5%	46.9%	46.8%	46.7%
Patient Co-morbidities	5.9 (3.4)	5.9 (3.4)	6.0 (3.4)	5.6 (3.2)	5.6 (3.2)	5.7 (3.2)
Employer-Based Plan	60.7%	74.2%	55.7%	57.7 %	71.3 %	52.0%
Plan Type						
PPO	65.7%	59.1%	67.2%	66.1%	60.7%	66.0%
HMO	10.7%	11.1%	11.6%	11.2%	11.9%	12.3%
POS	10.6%	10.8%	10.4%	12.1%	13.4%	11.4%
BMCOMP	7.6%	14.9%	4.3%	4.9%	9.52%	3.2%
CDHP	2.0%	1.7%	2.2%	2.4%	2.0%	2.7%
HDHP	0.2%	0%	0.5%	0.2%	0%	0.6%
Observations	3,673,943	639,526	1,262,527	4,135,972	704,020	1,307,996

by Medicare. Any variation in the utilization component between two episodes of care will be attributable to differences in the number of services used as opposed to differences in the prices charged for the same service.

The remaining component of the expenditure of an episode of care is the service price:

$$P_n = \frac{TE_n}{Q_n} \quad (3)$$

which is the price of the episode of care in terms of its total price per service.

Table 1 shows summary statistics for the MarketScan[®] sample.²² Note that due to how we defined services, the mean price per service will be approximately equal to one by construction. Prices for both samples rose only slightly over the sample period. Patient co-morbidities indicate the average number of concurrent diseases identified by the MEG. The cardiology sample contains older patients and more males than the orthopedics sample. Both samples have a high proportion of PPO plans accounting for about two thirds of all observations.

²²We removed outliers we believe are attributable to clerical data input error by discarding episodes in the bottom first percentile and top 99th percentile based on price per service and utilization.

3.2 SK&A[©] Data

The SK&A[©] database includes information on physician location (geocode), specialty, name, medical practice group, and health system. The database is updated every six months (half-year), spans 2005 to 2008, and claims to include 95 percent of office-based physicians practicing in the United States.²³ An important benefit of the SK&A data relative to other data sources is that they provide information about physician medical practice groups (i.e., firms). Another advantage is that each physician is verified over the telephone, which increases the accuracy of its physician location and group size information.²⁴

Given the different types of physician organizations, assigning each physician in the SK&A[©] data to a specific firm is still not a straightforward task. One difficulty is how to overcome the complexity in the vertical dimension. For instance, a small portion of physicians (6 percent of physicians in the SK&A data) are listed by SK&A as being a member of a group medical practice as well as a health system. Anecdotal evidence from physicians leads us to believe that bargaining in this case would take place at the larger health system level; therefore we make the assumption that physicians use their full market power whenever possible.²⁵ Thus, for each physician we assign the broadest medical group or system she was assigned in the data. Specifically, if the physician is not associated with a health system we assign her to the group medical practice she is listed with.

We summarize the number of physicians and physician firms in the SK&A data in the top portion of Table 2. In order to compare the dataset to the AMA data, we also report AMA physician information. The table shows that the AMA has a higher count of total physicians. This may be due to the fact that the AMA has a unique data base of physician information that SK&A does not have access to and may do a better job

²³SK&A has a research center that verifies every field of every record in its database. The data also includes the names of DOs, NPs, PAs and office managers.

²⁴The six month frequency of their telephone survey may be important, since SK&A reports that on average, 14.2% of physicians move each year. Although all the information in the survey is telephone verified, they gather information for physicians through a variety of sources. This includes company and corporate directories, websites, state licensing information, mergers and acquisitions announcements, trade publications, white and yellow pages directories, professional associations, and government agencies.

²⁵This is consistent with the common assumption made in the hospital literature that the hospitals bargain at the system level. SK&A does not provide information about the physician-hospital relationship, such as whether the physician is an employee of the hospital or whether the physician just has admitting privileges. As we can only match SK&A with MarketScan via the county (not at the provider level) we can not back out the relationship through MarketScan in any way. However, as a robustness exercise, we changed the definition of the FTHHI to include only group medical practices and our qualitative results did not change.

Table 2: SK&A[©] Descriptive Statistics

	Cardiology			Orthopedics		
	Total Sample	2005	2008	Total Sample	2005	2008
Number of Physicians (SK&A Data)		17,345	18,254		17,962	18,205
Number of Physician Firms (SK&A Data)		4,085	4,660		5,999	6,220
Number of Physicians (AMA Data)		20,317	20,756		22,961	23,616
Number of Office-Based Physicians (AMA Data)		17,316	17,165		18,969	18,982
Physician Market Boundary Defined by County Border						
	<u>No Travel Costs</u>					
Physician HHI County Boundary	0.161 (0.197)	0.154 (0.191)	0.159 (0.194)	0.180 (0.222)	0.173 (0.218)	0.175 (0.217)
Physician Market Boundary Defined by Driving Times						
	<u>No Travel Costs</u>					
Physician FTHHI 60 Min. Boundary	0.175 (0.221)	0.181 (0.231)	0.170 (0.219)	0.132 (0.185)	0.130 (0.186)	0.130 (0.184)
	<u>Travel Costs Proportional to Driving Time</u>					
Physician FTHHI 20 Min. Boundary	0.412 (0.311)	0.419 (0.318)	0.403 (0.308)	0.359 (0.291)	0.362 (0.295)	0.354 (0.289)
Physician FTHHI 40 Min. Boundary	0.269 (0.276)	0.276 (0.284)	0.261 (0.271)	0.219 (0.241)	0.220 (0.243)	0.216 (0.239)
Physician FTHHI 60 Min. Boundary	0.201 (0.235)	0.207 (0.244)	0.194 (0.231)	0.112 (0.118)	0.156 (0.200)	0.154 (0.199)
Physician FTHHI 80 Min. Boundary	0.161 (0.206)	0.167 (0.215)	0.157 (0.205)	0.123 (0.175)	0.122 (0.176)	0.122 (0.174)

Notes: The table reports county population-weighted means of the concentration measures. We use 2300 counties in our analysis.

of getting physicians in hospitals or in staffing models. However, we were told that the SK&A verification is very systematic and may be better at picking out doctors that are currently not practicing. For instance, many of the AMA physicians may be researchers, retired physicians who keep their medical license, or other non-practicing physicians. It is interesting to note that the counts are more similar when comparing SK&A to the AMA's office-based physician count.

Pinpointing the geographic market for provider services is also a challenging task, and has been the subject of many antitrust cases (see Gaynor and Haas-Wilson [1999] and Haas-Wilson [2003]). Neither the Justice Department nor the Federal Trade Commission have a set standard as to how to measure the size of a geographic market for medical services.²⁶ For this reason, in creating our measure of the geographic market, we use a battery of different measures, each based on different assumptions about geographic market size and

²⁶Although many experts agree that the merger guidelines provide an appropriate framework for defining and analyzing geographic markets in the health care sector, there is no consensus for the precise methodology that should be used across all markets (See FTC and DOJ [2004]).

patients' preference for travel. We use as much of the granularity of the physician-location information in the SK&A data as possible, but, we are ultimately constrained by the fact that it will eventually be linked to the MarketScan[®] data, which only has geographic information about the physician's and patient's county. We create three types of physician concentration measures:

- A** - Physician market boundary defined by county border.
 - No travel costs
- B** - Physician market boundary defined by maximum travel time.
 - No travel costs
- C** - Physician market boundary defined by maximum travel time.
 - Travel costs proportional to travel time

We will label measure **A** a physician-firm Herfindahl-Hirschman index (HHI) and measures **B** and **C** physician firm “fixed-travel-time” HHIs (FTHHI). It is important to note that these are each calculated in similar fashion to Kessler and McClellan [2000] in that they are based solely on information about the physician's group size and distance to patients. The concentration measures we construct therefore do not include any information about the physician firms' actual shares which may be tainted with information about the quality of the physician firm. While it would be interesting to compare our measures to an HHI based on actual market shares, we cannot construct such a measure using the MarketScan[®] data. Although there does exist a “provider ID” in the MarketScan[®] data, this variable is coded by the data contributors, not Thomson Reuters. Therefore we use caution when applying the provider ID variable since distinct data contributors may assign different IDs to the same provider.

3.2.1 Construction of FTHHI

There is a four-step process in creating the physician concentration measures. First, we define a geographic market boundary. Second, we calculate the probability that a person located within the market boundary will visit a physician firm. This step is crucial as we are calculating probabilities based *solely* on information about the *distance* between people and physicians. Third, using the probabilities of seeing each physician calculated in step two, we calculate expected market shares. Fourth, using these expected market shares and physician group information, we construct concentration measures specific to a

county and time period.

Defining the Market Boundary

For measure **A**, we simply define the market boundary as the county border. For measures **B** and **C**, we define the market boundary as a geographic distance surrounding a given patient, as would be done in a standard Hotelling problem. Since the most granular U.S. population data is at the census-tract level, we define market boundaries as fixed distances surrounding the centroid of each census tract. To correct for ease of travel in a certain geographic area, we set the boundary as a maximum amount of driving *time*, \bar{k} .²⁷ Specifically, for each census tract's centroid geographic location we define a latitude and longitude location as a vector $x = \{lat, long\}$. Using Google's Maps software we can measure a maximum radial distance based on specific amount of driving time \bar{k} .²⁸

Calculating the probability of a patient visiting a physician

Under assumptions **A** and **B**, the probability that a patient sees a given physician will not depend on the distance between the patient and the physician as long as the physician is located within the market boundary. Under assumption **C**, however, patients earn negative utility for each extra minute of travel time to the physician. Specifically, the probability of whether a patient located at x_0 would be willing to travel to a physician located at x_i will be based on the travel time between them. For a patient located at x_0 , we define their driving time to a physician located at x_i as k_{x_i} . It follows that a patient who lives at location x_0 resides k_{x_i} minutes away from the physician located at x_i . We create a variable which represents the probability that a patient located at x_0 would consider traveling to the physician located at x_i . We do this in the most tractable manner possible by assuming that patients' idiosyncratic taste shocks lie on the uniform distribution and that k_{x_i} is directly proportional to travel costs. Specifically, a patient will choose a physician located at x_i instead of a physician located at x_0 if $V - k_{x_i} + \varepsilon_{i0} > V - k_{x_0}$ where V is the patient valuation of treatment and ε_{i0} is a patient taste shock of traveling from x_i to x_0 which lies on the uniform distribution between 0 and \bar{k} . As $k_{x_0} = 0$ by construction, it follows that a patient located at x_0 would be willing to travel to x_i (that is, travel k_{x_i} minutes) with

²⁷Driving times were calculated in Stata using the 'traveltime' command developed by Ozimek and Miles. This command finds the driving time between two latitude and longitude points via Google maps.

²⁸To do so, for each county, c , we drew a random coordinate and then calculated the average speed, $speed_c$, one could travel 0.1 degrees north, south, east, and west latitude. We use the Stata package, "traveltime," written by Ozimek and Miles. This allows us to define a maximum radial distance for any latitude and longitude coordinate in county c as $\bar{k} * speed_c$.

probability:

$$Pr(\varepsilon_{i0} > k_{x_i}) = \begin{cases} 1 - (1/\bar{k})k_{x_i} & \text{if } k_{x_i} \leq \bar{k} \\ 0 & \text{if } k_{x_i} > \bar{k} \end{cases} \quad (4)$$

Constructing Expected Market Shares

For measure **C**, we treat the probabilities from (4) as the expected quantities in constructing market shares at given census-tract centroid. This means the expected market share of a physician located at x_i for patients located at census-tract centroid x_0 is $E[S_{x_i}(x_0)] = \frac{Pr(\varepsilon_{i0} > k_{x_i})}{\sum_j Pr(\varepsilon_{j0} > k_{x_j})}$ where j indexes each physician in the database. It follows that the expected market share at location x_0 for physician *group* i that has N_i physicians in the group, located at x_i is $E[S_{x_i}^*(x_0)] = \frac{N_i Pr(\varepsilon_{i0} > k_{x_i})}{\sum_j N_j Pr(\varepsilon_{j0} > k_{x_j})}$. For measures **A** and **B** we assign expected shares based solely on the physician firm’s group size relative to the number of physicians within the market boundary. That is, if physician group i contains 10 physicians, and there exist 100 physicians within the market boundary, the physician group i ’s market share is 10 percent. Measures **A** and **C** are equivalent to measure **C** if we supposed that all physicians within the market boundary resided exactly the same distance away from the centroid. For example, supposed there exist ten physicians all residing exactly at location x_0 while every other physician in the data resides over \bar{k} minutes away. It follows that each of these ten physicians has equal probability of attracting patients from location x_0 , resulting in each having an expected market share of 0.1 for patients located at x_0 .

Construct Concentration Measures

For measure **A**, we calculate an HHI at the county level in a given half-year, HHI_{ct} , using the respective expected market shares calculated in step three. For measures **B** and **C** we first calculate a “fixed-travel-time HHI” at the census tract level $FTHHI_{ht}$. Specifically, for each census-tract with centroid geocode, x_h , we calculate a distinct $FTHHI_{ht} = \sum_i E[S_{x_j}^*(x_h)]^2$ based on the expected market shares at census-tract centroid x_h . We then create a fixed-travel time concentration measure for the county, $FTHHI_{ct}$, as the weighted sum of the $FTHHI_{ht}$ measures, where the weights are the proportion of the county’s population from the given census tract.

It is important to note that for hospitals it is possible to define the market based on a demand estimate using a discrete-choice framework where patients choose among a discrete set of hospitals (see Town and Vistnes [2001] and Capps, Dranove, and Satterthwaite [2003]). However, this paper takes a more reduced form approach for three reasons. First, the discrete-choice framework applied in the hospital literature is not possible with our

data because we do not have geographic information in the MarketScan[®] data at the zip code level (that is, MarketScan[®] tracks providers and patients at the county level). Second, the number of physician firms is magnitudes larger than the number of hospitals, which means the number of possible physician choices becomes quite large. Third, the effects of competition among physicians are not well understood or documented, so as a first step in analyzing this market we focus more directly on the relationship between the competitive environment and its effects on service prices and outcomes. For these reasons, this paper more closely follows papers that apply more reduced form techniques (for example, Lynk [1995], Dranove and Ludwick [1999], Kessler and McClellan [2000], Duggan [2002], and Dranove et al. [2008]).

3.2.2 Summary Statistics

The bottom portion of Table 2 provides summary statistics for the physician concentration measures based on the SK&A data. The table reports county population-weighted means of the concentration measures. Interestingly, the *FTHHI* constructed using a 60 minute boundary and assuming no travel costs lines up with the HHI created using the county border. These two measures also line up with the *FTHHI* constructed using an 80 minute boundary with travel costs. This is likely due to the fact that in the latter measure those physicians lying beyond 60 minutes from the centroid are given less weight.

For comparison purposes, we also created *FTHHI* measures using smaller market boundaries. As expected, concentration declines as the market boundary lines are increased. However, there is not much time-series variation in the mean concentration measures over the sample period. The orthopedist market is slightly less concentrated than the cardiology sample. Overall, the physician-firm concentration measures are low compared to other industries, indicating that the physician market is relatively competitive.

3.3 HealthLeaders-InterStudy[©] Data

Enrollment information on health insurers is obtained from the HealthLeaders-InterStudy[©] database of insurance carriers for the years 2005 to 2008. This MSA level enrollment data are collected through a biannual survey of health insurance carriers where they are asked to report enrollment by geographic location. The enrollment information for each insurance carrier is also provided by the type of health insurance plan (that is, PPO, POS and

HMO)²⁹ and also whether the contract is fully-insured or self-insured.³⁰

Using this enrollment data, we construct an HHI concentration measure for the health insurance market. The HHI measure is constructed based on the share of total enrollment for each plan. Specifically, we let S_{ins} be the share of enrollment for an insurance carrier in an MSA, then the concentration measure for the enrollee is $HHI_{ins} = \sum_{ins \in MSA} (S_{ins})^2$.³¹ The population-weighted mean concentration over the sample period was 0.286.

3.4 Demographic Data - Area Resource File & Census Data

For additional information regarding the demographic information in a county area we use data from the Area Resource File (ARF). The ARF is a database containing extensive information for U.S. counties: information on demographics, health facilities, health professionals, measures of resource scarcity, health status, and economic activity. The data are gathered from various sources, often on an annual basis.³² The variables constructed from these data that are used in our analysis include median household income, education, population, population over the age of 65, hospital facility characteristics and a number of

²⁹Prior to 2004 HealthLeaders-InterStudy[©] collected data on only HMOs, but they significantly expanded the coverage of their plan survey in 2004. Prior to 2006 they did not separately report POS, but included this enrollment as part of the HMO category.

³⁰A fully-insured health insurance contract is a contract purchased from an insurer where the insurer assumes the full risk of the individual. All other contracts are considered self-insured.

The American Medical Association (AMA) [2010] produces health insurance concentration figures for MSAs across the United States using HealthLeaders-InterStudy[©]. In general, we follow many of the AMA guidelines for calculating concentration measures using HealthLeaders-InterStudy[©] data. Specifically, we exclude PPO rental networks (e.g. Beech Street Corporation). These companies provide administrative services only and/or contract with health insurance carriers, which may cause double counting for those enrollees that are enrolled in another insurance plan that also contracts with a PPO rental network. We also exclude markets where HealthLeaders-InterStudy[©] data do not capture a plausible fraction of the insured population. Specifically, we calculate the ratio of total enrollment to the total eligible enrollment (i.e. population-uninsured-(Medicare+Medicaid-Dual)) estimated fraction of total possible enrollment in the market. Similar to the AMA, we exclude those MSAs where the ratio is less than 30 percent. Unlike the AMA concentration measures that only includes HMO and PPO enrollment we also include POS enrollment.

³¹As an alternative to the total enrollment, we also constructed an HHI based solely on the fully-insured insurance share information, and we obtain similar results.

³²Some of the sources included Census, the American Hospital Association database, American Medical Association database.

additional variables.³³

4 Effects of Concentration on Service Prices

In this section we estimate the extent to which physician concentration affects physician service prices. In the first subsection we will exploit variation in concentration across counties within the same state. In the following subsection, we will assess variation in concentration across cardiologists and orthopedists within the same county. In the third subsection, we will perform a panel estimation exploiting only variation in concentration over time.

4.1 Cross-Sectional Within-State Specification

The following regression quantifies the impact of the relative physician-insurance carrier bargaining leverage on the logarithm of service price P_{nt} :

$$\ln(P_{nt}) = \beta_1 \ln(FTHHI_{ct}) + \beta_2 \ln(HHI_{mt}^{ins}) + \delta'X + \zeta_{at} + \zeta_d + \zeta_{sev} + \varepsilon_n. \quad (5)$$

where each episode, n , is uniquely associated with a patient k , a disease d , severity sev , a physician p , an MSA m in a county c , and state a . This specification essentially splits our measure of bargaining power leverage, Z , into its two components, $FTHHI_{ct}$ and HHI_{mt}^{ins} .³⁴

In this section, we isolate variation occurring between counties within a state by including state-time fixed effects, ζ_{at} . We also include disease, ζ_d , and stage-of-illness fixed-effects, ζ_{sev} , defined by the MEG. Specifically, the MEG algorithm classifies an episode of care into five major stages of illness and is meant to indicate the severity of a particular episode compared with other episodes in that disease group.³⁵ To decrease computational burden,

³³Some of the additional variables include rental value of property, population over the age of 65 and share of hospitals that are university facilities.

³⁴It would be equivalent to using Z as a covariate if we were to constrain $\beta_1 = -\beta_2$.

³⁵Specifically, MEG assigns a severity score to each patient episode based on the ‘‘Disease Staging’’ disease progression model and does not depend on the utilization of care. Stage 0 represents a history or suspicion of a condition, exposure to a disease, or well visits. Stage 1 represents conditions with no complications or problems with minimal severity. Stage 2 represents problems limited to a single organ or system, significantly increased risk of complication than Stage 1. Stage 3 represents multiple site involvement, generalized systemic involvement, or poor prognosis and Stage 4 represents death.

we include only the 100 most common disease groups for each specialty, which represents over 90 percent of the total samples.³⁶

The vector X includes a host of covariates aimed at controlling for the physician’s cost and quality, as well as the patient’s demographic factors. Please see the Appendix for a more comprehensive description of these variables. It includes a third-order polynomial in the patient’s age, a dummy variable indicating the patient’s gender, as well as a polynomial in the number of co-morbidities of the patient. This latter variable is meant to control for those patients with multiple diseases, who may be sicker or harder to treat than patients with only a single disease. The patient-specific variables also include the patient’s type of insurance carrier (for example, HMO, PPO, etc.), whether the patient works for a larger employer³⁷, the logarithm of the median income of the patient’s county, as well as the logarithm of the fraction of college educated individuals in the patient’s county.

To control for the physician’s quality, we include the percentage of hospitals in the physician’s county that are affiliated with a university as well as a weighted average of the patient’s county-level median income.³⁸ We also attempt to control for the physician’s cost. This includes the logarithms of the median rent, median home price, median income and average health care facility wage in the physician’s county. These cost variables were chosen as controls because fees are usually bargained as a percentage of Medicare prices, which vary by cost-of-living variables such as rent, wages, and house prices. See the Appendix D for specifications with additional controls that include average firm size in the county (i.e. scale effects) and the number of physicians per capita in the county (i.e. supply effects).³⁹

4.1.1 Correcting for potential omitted-variable bias

The reason for including the controls described above is that they account for the many factors used in physician-insurance carrier bargaining. For instance, we include cost-of-living variables because physicians and insurers often bargain off of Medicare’s relative

³⁶No results changed when all diseases were included on a 30 percent subsample of the data.

³⁷This is actually based on an indicator of whether the data source for the claims information is from an employer (which is typically a large employer) or from a health insurance firm.

³⁸The basic idea is that the higher quality doctors may attract the more wealthy patients. The weighted average is the average income of patients that see a particular doctor (based on county-level income data). This income variable is an average across patients seeing a particular doctor, which is distinct from the patient income variable that enters as a demographic variable.

³⁹We chose not to include these variables in our main specification because they are likely endogenous variables. Gaynor and Haas-Wilson [1999] note that “the extant literature on physician groups suggests that scale economies for such practices are also exhausted at relatively small sizes—three to five physicians (Pope and Burge [1996]).”

value unit system. It is important to control for these cost-of-living factors because they may also affect the level of concentration of physicians and insurance firms. For example, areas with high rent may raise prices and also dissuade physicians from locating in a given county. Estimation bias can still arise, however, if important variables used in bargaining exist that are unobserved to the econometrician and also affect concentration. There are many examples of omitted variables, but one that has been widely discussed in the literature is unobserved quality. Higher physician quality may result in larger negotiated fees, but it may also draw more patients to see a physician firm thereby increasing its market share and the concentration of the market. This type of bias is particularly dangerous because it will bias the estimate on physician concentration upward, causing us to mistake high prices attributable to quality as being attributable to high concentration.

A major benefit of our physician concentration measures is that they are constructed using theoretically predicted market shares, based on physician firm size and the distance between potential patients and physician firms. This is in contrast to constructing an HHI based on actual market shares. This approach is analogous to that taken by Kessler and McClellan [2000] who construct an HHI for hospitals using predicted market shares based on travel distances between patients and hospitals. Similarly, the predicted shares used in the *FTHHI* measure are based solely on the number of physicians in the firm as well as the patient's travel time to the firm. As mentioned previously, Kessler and McClellan argue that this removes any endogeneity that may be attributable to higher quality providers attracting more patients.

This addresses concern about unobserved quality in the physician concentration measure. However, we have not addressed unobservable (to the econometrician) variables that affect the physician's decision to enter a geographic market or join a group practice. We argue that this remaining bias will push the estimated coefficient on the *FTHHI* downwards, meaning our OLS estimate should be interpreted as a lower bound of the effect of concentration on service prices. Specifically, if fees are low in a particular market due to some unobserved factor, this will either entice physicians to join group practices or will deter physicians from entering the geographic market. Both of these features will cause the *FTHHI* to be low when unobservable variables cause service prices to be high, biasing the OLS *FTHHI* coefficient downwards.

Finally, our estimation strategy also includes the insurance market concentration measure, which is based on actual, rather than predicted market shares. This is problematic since a plan with unobserved benefits may affect the negotiated price, but it may also increase a given insurance carrier's market share. Also, unobservable variables that cause

service prices to be high are likely to deter insurance carriers from entering the market. This latter effect will bias the insurance carrier *HHI* coefficient upward—higher quality plans are likely to have a higher market share but presumably more market health insurers will have higher costs upon entering hence drawing less of them into the market.

To help mitigate this remaining omitted-variable bias, we use a battery of instrumental variable sets. Our instrument sets are motivated from studies by Berry and Waldfogel [2001], Davis [2006a], and Baker and Corts [1996]. The key to a good instrumental variable estimation strategy is to identify competitive variation solely attributable to the long-run decisions of physicians and insurers—modeled as “Period 0” in our theoretical framework. Specifically, instruments that relate to either the fixed cost of entering the market or the market size are most appropriate, since they affect the long-run market-structure decisions of insurers and physicians, but do not affect their pricing decision in Period 1, *except* through the impact on the number of rivals in the market (see equation (13) in the Appendix). Berry and Waldfogel [2001] use population terms as instruments for radio broadcasting concentration, while Davis [2006a] uses population counts as instruments for his market structure variables in the movie-theater industry. Baker and Corts [1996] use firm size distribution variables to instrument for HMO market penetration.⁴⁰ We use four different instrument sets based on this literature. Three sets are based on U.S. population counts while the fourth set is based on the distribution of U.S. business establishments. Both instrument sets take into account that for clean identification, we need instruments that are correlated with insurance and physician competitive decisions *uniquely*.

Our first three instrument sets, which we label “population-distribution instruments,” includes populations of certain age groups as well as different employment statuses:

Population Distribution Instrument Sets:

Pop.I: County Population, MSA Population, County Population Above Age 65, Unemployment Rate

Pop.II: County Population, MSA Population, County Population Above Age 65, County Population Ages 35 to 45, County Population Ages 45 to 55, County Population Ages 55 to 65

⁴⁰Similar studies in the hospital literature have found it crucial to use instrumental variables to account for unobserved quality. As a recent example, Dranove et al. [2008] provides an instrumental variable strategy for estimating the effects of concentration on price in hospital markets.

Findings in the physician literature also suggest that price may be endogenous. Frank [1985] finds that psychiatrists respond to price; Schwartz et al. [1980], Newhouse et al. [1982], find that physicians locate in response to effective demand.

Pop.III: County Population, MSA Population, County Population Above Age 65, Unemployment Rate, County Population Ages 35 to 45, County Population Ages 45 to 55, County Population Ages 55 to 65

where all variables are in logarithms and the unemployment rate is in a third-order polynomial. Note that the second instrument set does not include the unemployment rate. A fewer number of senior citizens should encourage less entry from physician firms and encourage more physicians to form groups to attract patients. Insurance carrier firms should be less affected by this variable since these are generally patients already covered by Medicare. We also include the population of employed individuals (the unemployment rate) for a similar reason. Insurance carriers are more likely to enter geographic areas with more employed individuals where the base of potential customers is higher. Physicians, however, are more indifferent to this factor because unemployed individuals are often covered by Medicaid or COBRA. In particular, we expect there to be a larger number of physician firms and insurance firms in more populated markets. Unlike prior work that uses population as instruments in a model of competition using aggregate data (for example, Davis [2006a] and Berry and Waldfogel [2001]), here we use detailed micro level data to control for numerous factors at the level of the patient, so there is little reason to expect population to be correlated with physician quality. If, for some reason, higher quality physicians prefer to practice medicine in more populated areas, our estimates will be attenuated towards zero statistical significance. In this sense, our estimates will be conservative.⁴¹

Our second instrument set, which is labeled “firm-distribution instruments,” consists of the number and size distribution of business establishments in the county taken from U.S. Census Bureau’s County Business Patterns database:

Firm Distribution Instrument Set:

Firm: Total number of firms, Fraction of firms with less than 20 employees, Fraction of firms with greater than 20 and less than 50 employees, Fraction of firms with greater than 50 and less than 100 employees, Fraction of firms with greater than 100 employees

⁴¹One may be concerned that population may be correlated with physicians per capita. However, we show in the Appendix that results do not change when we include the number of physicians per capita as a control variable.

These variables are meant to capture the variation in competitive conditions of *all* industries in the market. We include the size distribution of the firms because insurance-carrier entry may be more affected by larger firms than smaller firms since larger firms are more likely to offer health insurance to their employees and presumably demand more insurance variety for their larger employee bases.⁴² The size distribution may also be related to the expected profitability from the type of insurance purchased by smaller firms, that tend to purchase full insurance, and larger firms, that tend to purchase self-insurance.

Whereas the population-distribution instruments are designed to pick up cross-sectional variation in the exogenous characteristics of the market that determine entry, the firm-distribution instruments are designed to pick up the ex-post cross-sectional variation in the entry and exit of firms whose decisions are presumably exogenous to the physician and insurance market. The firm-distribution instruments may be related to not only the size of the market, but also the fixed cost of entering a market that are common across firms of different industries.

4.1.2 Cross-Sectional Within-State Results

We report results of specification (5) in Tables 3 and 4. Standard errors are clustered by county. This degree of clustering is meant to control for any correlation in bargaining between physicians and insurance firms within the same county.⁴³

Table 3 shows estimates using concentration measures **A** and **B**, where we have assumed no travel costs. This table includes regression estimates of β_1 and β_2 from a total of 20 regressions, 10 from the cardiology sample and 10 from orthopedics sample.⁴⁴ Specif-

⁴²In 2008, 96.5 percent of firms with more than 50 employees offered insurance, while only 43.2 percent of firms with fewer than 50 employees offered insurance (See the Medical Expenditure Panel Survey - Insurance Component Table I.A.2). Gruber and Lettau [2004] show similarly large differences in the offer rates of large and small firms, even after controlling for a multitude of other factors. In 2008 for those employees working for firms with fewer than 50 employees, only 26.8 percent are offered more than two insurance plans. In contrast, for employees working for firms with 50 or more employees, 73.7 percent are offered two or more health plans (See the Medical Expenditure Panel Survey - Insurance Component Table I.B.2.c).

⁴³We also estimated a different specification of the episode price, P_n , regression where we used procedure price, p_j , as the dependent variable while including procedure fixed effects. This specification will be identical to specification (5) if physicians bargain with insurance carriers according to a discount on *all* procedures. That is, if $p_{jn} = \theta_n r_j \forall j$ for some $|\theta_n| < 1$, then it follows that $\ln(P_n) = \ln(\frac{p_{jn}}{r_j})$, which is equivalent to $\ln(\theta_n)$ as the dependent variable. No results changed using this specification indicating that, on average, physicians likely bargain over their entire fee schedule.

⁴⁴To keep the table a reasonable size we do not report additional statistics such as estimates of coefficients

Table 3: Cross-Sectional Within-State Estimates: County Boundary versus Travel-Time Boundary

	Cardiology					Orthopedics				
	OLS	IV				OLS	IV			
	Pop. I	Pop. II	Pop. III	Firm Dist.	Pop. I	Pop. II	Pop. III	Firm		
Physician Market Boundary Defined by County Border										
<u>No Travel Costs</u>										
Physician HHI County Boundary	0.022*** (0.005)	0.024*** (0.008)	0.022*** (0.008)	0.023*** (0.007)	0.023*** (0.008)	0.025*** (0.005)	0.021*** (0.007)	0.021*** (0.007)	0.021*** (0.007)	0.018** (0.008)
Insurance HHI	0.029** (0.013)	0.145* (0.078)	0.185** (0.082)	0.131* (0.073)	0.192** (0.088)	0.030** (0.012)	0.126** (0.062)	0.099 (0.065)	0.126 (0.060)	0.146* (0.087)
R^2	0.117	0.111	0.107	0.113	0.106	0.192	0.187	0.189	0.191	0.184
Physician Market Boundary Defined by Driving Times										
<u>No Travel Costs</u>										
Physician FTHHI 60 Min. Boundary	0.030*** (0.007)	0.067*** (0.019)	0.056*** (0.013)	0.059*** (0.013)	0.054*** (0.013)	0.023*** (0.008)	0.062** (0.026)	0.080** (0.032)	0.071*** (0.022)	0.055** (0.022)
Insurance HHI	0.216 (0.013)	-0.249 (0.162)	-0.128 (0.124)	-0.172 (0.116)	-0.002 (0.114)	0.026** (0.012)	-0.129 (0.159)	-0.263 (0.208)	-0.192 (0.130)	-0.027 (0.142)
R^2	0.120	0.087	0.110	0.103	0.113	0.192	0.174	0.111	0.163	0.186

Notes: The table above shows estimates of the coefficients on the physician and insurance concentrations measures for ten separate regressions for each of the cardiology sample and the orthopedic sample. This includes a regression on two unique concentration measures using five unique estimation methodologies. The dependent variable for all regressions is the logarithm of service price, $\ln(P_{nt})$. All regressions include the controls specified in equation (5). Standard errors are in parentheses and are clustered by county. One, two, and three asterisks indicate significance at the 10-percent, 5-percent, or 1-percent significance level, respectively. See the Appendix for estimates that include additional controls for physician firm size and physicians per capita.

ically, we report five different specifications (OLS and four different instrument sets) for regressions using two different physician concentration measures. There is a positive and statistically significant effect of physician concentration on service prices for all estimates. The OLS estimates indicate that a 10 percent increase in physician concentration will cause about a 0.2 to 0.3 percent increase in fees, however, they also show a *positive* and significant relationship between insurance concentration and service prices. Using instrumental variables on the $FTHHI$ appears to remove some upward bias on HHI^{ins} as well as some downward bias on the physician concentration measures. Interestingly, the instruments perform poorly for the physician HHI defined by county borders. This should not be entirely surprising, given the weak theoretical justification for using county borders to define markets.⁴⁵

Table 4 reports estimates using concentration measure **C** under four different travel-time boundaries. Estimates do vary a bit according to the market boundary. Specifically, a larger physician market boundary is associated with a larger estimate on the physician concentration estimate and a larger (i.e. more negative) estimate on the insurance concentration estimate. It is difficult to assess which is the “correct” measure of the market boundary. On one hand, joint significance on β_1 and β_2 tends to increase with the size of the market boundary which may indicate that the larger boundary measures provide a better match to the marketplace.⁴⁶ On the other hand, the models using smaller market boundaries produced larger R^2 in many cases. In any case, we found it striking that there remained a positive and significant effect of physician concentration on service prices even at the 20-minute travel-time boundary. This would indicate that the physician market may be considerably smaller in size than a county or MSA, which is consistent with what has been found in papers analyzing competition in hospital markets (see Capps et al. [2003]).

Patient-Flow Weighted Concentration Measures

To construct a more precise measure of physician concentration, we use the physician ID information available in MarketScan[®]. As we mentioned earlier, the physician ID variables are created by the institutions providing data to Thomson Reuters, which is likely problematic for creating a concentration measure. Specifically, it is likely that each

on the control variables as well as the number of observations.

⁴⁵One possibility explaining the positive coefficient on the insurance variable is that the physician HHI is likely to be very poorly measured. In these cases, the insurance HHI may be picking up less concentrated MSAs, where physician market power is likely to be high.

⁴⁶The larger point estimate on the physician concentration measures with larger boundaries may also be due to the fact that the measures with larger boundaries have smaller mean concentrations.

Table 4: Cross-Sectional Within-State Estimates: Travel-Time Boundary with Travel Costs

	Cardiology					Orthopedics				
	OLS	IV				OLS	IV			
		Pop. I	Pop. II	Pop. III	Firm		Pop. I	Pop. II	Pop. III	Firm
Physician Market Boundary Defined by Driving Times										
<u>Travel Costs Proportional to Travel Time</u>										
Physician FTTHI 20 Min. Boundary	0.025*** (0.009)	0.054*** (0.014)	0.037** (0.016)	0.039** (0.014)	0.038** (0.015)	0.035*** (0.006)	0.057*** (0.018)	0.043** (0.019)	0.051*** (0.020)	0.018 (0.0174)
Insurance HHI	0.029** (0.013)	0.012 (0.096)	0.138 (0.093)	0.083 (0.084)	0.191** (0.089)	0.029*** (0.011)	-0.006 (0.086)	0.026 (0.090)	-0.023 (0.099)	0.181* (0.094)
R^2	0.117	0.115	0.111	0.115	0.104	0.192	0.190	0.192	0.190	0.179
Physician FTTHI 40 Min. Boundary	0.025*** (0.007)	0.050*** (0.011)	0.038*** (0.011)	0.041*** (0.010)	0.035*** (0.012)	0.029*** (0.006)	0.049*** (0.017)	0.057*** (0.019)	0.056*** (0.017)	0.024* (0.014)
Insurance HHI	0.025* (0.013)	-0.096 (0.116)	0.032 (0.101)	-0.021 (0.092)	0.148 (0.094)	0.025** (0.011)	-0.063 (0.109)	-0.141 (0.137)	-0.131 (0.107)	0.129 (0.101)
R^2	0.118	0.110	0.117	0.116	0.110	0.192	0.187	0.175	0.177	0.186
Physician FTTHI 60 Min. Boundary	0.028*** (0.007)	0.061*** (0.012)	0.047*** (0.012)	0.045*** (0.012)	0.051*** (0.011)	0.026*** (0.006)	0.057*** (0.021)	0.075*** (0.029)	0.065*** (0.020)	0.044** (0.017)
Insurance HHI	0.022* (0.013)	-0.217 (0.113)	-0.064 (0.113)	0.060 (0.106)	-0.121 (0.106)	0.024** (0.011)	-0.126 (0.142)	-0.271 (0.206)	-0.191 (0.127)	0.012 (0.126)
R^2	0.118	0.092	0.114	0.109	0.116	0.192	0.177	0.138	0.163	0.190
Physician FTTHI 80 Min. Boundary	0.031*** (0.007)	0.075*** (0.023)	0.056*** (0.013)	0.060*** (0.014)	0.060** (0.013)	0.023*** (0.007)	0.071*** (0.031)	0.089** (0.037)	0.077*** (0.0257)	0.078** (0.030)
Insurance HHI	0.019 (0.012)	-0.319 (0.201)	-0.124 (0.127)	-0.182 (0.123)	-0.040 (0.124)	0.024** (0.011)	-0.194 (0.188)	-0.318 (0.245)	-0.234 (0.149)	-0.147 (0.184)
R^2	0.119	0.068	0.109	0.100	0.114	0.191	0.159	0.117	0.148	0.166

Notes: The table above shows estimates of the coefficients on the physician and insurance concentrations measures for 20 separate regressions for each of the cardiology sample and the orthopedic sample. This includes a regression on four unique concentration measures using five unique estimation methodologies. The dependent variable for all regressions is the logarithm of service price, $\ln(P_{nt})$. All regressions include the controls specified in equation (5). Standard errors are in parentheses and are clustered by county. One, two, and three asterisks indicate significance at the 10-percent, 5-percent, or 1-percent significance level, respectively. See the Appendix for estimates that include additional controls for physician firm size and physicians per capita.

Table 5: Cross-Sectional Within-State Estimates: Patient-Flow Weighted Physician FTHHI

	Cardiology					Orthopedics				
	OLS	IV				OLS	IV			
	Pop. I	Pop. II	Pop. III	Firm	Pop. I	Pop. II	Pop. III	Firm		
Physician Market Boundary Defined by Driving Times										
Travel Costs Proportional to Travel Time										
Physician FTHHI 20 Min. Boundary	0.051*** (0.008)	0.078*** (0.013)	0.076*** (0.012)	0.078*** (0.012)	0.061*** (0.016)	0.051*** (0.008)	0.056*** (0.013)	0.053*** (0.013)	0.056*** (0.013)	0.037** (0.015)
Insurance HHI	0.020 (0.012)	0.005 (0.078)	-0.006 (0.074)	-0.043 (0.074)	0.112 (0.089)	0.024** (0.011)	0.052 (0.119)	0.023 (0.067)	0.000 (0.061)	0.102 (0.096)
R^2	0.120	0.119	0.119	0.117	0.116	0.194	0.196	0.194	0.194	0.191
Physician FTHHI 80 Min. Boundary	0.043*** (0.007)	0.084*** (0.017)	0.089*** (0.015)	0.089*** (0.016)	0.076*** (0.017)	0.038*** (0.008)	0.084** (0.025)	0.098*** (0.025)	0.094*** (0.023)	0.099** (0.039)
Insurance HHI	0.0165 (0.013)	-0.199* (0.111)	-0.224** (0.109)	-0.251** (0.106)	-0.090 (0.127)	0.024** (0.011)	-0.112 (0.119)	-0.205* (0.122)	-0.180* (0.103)	-0.233 (0.212)
R^2	0.121	0.099	0.093	0.088	0.114	0.193	0.178	0.156	0.163	0.149

Notes: The dependent variable for all regressions is the logarithm of service price, $\ln(P_{nt})$. All regressions include the controls specified in equation (5). Standard errors are in parentheses and are clustered by county. One, two, and three asterisks indicate significance at the 10-percent, 5-percent, or 1-percent significance level, respectively. See Appendix for first-stage estimates.

actual physician may have multiple provider IDs in the data. Although this issue makes constructing an HHI problematic, it does give valid information about which county a given provider ID's patients are traveling from. Thus, we can create an FTHHI measure that is specific to each provider ID. We do so by taking a weighted average of the $FTHHI_{ct}$ for each provider ID, where the weights are based on the percentage of the provider ID's patients from county c in time t . Ultimately, this may be a better measure of the physician's actual market power, if for instance, the physician firm is located near the border of a county. In this instance, a large share of the physician's patients will be from the bordering county, in which case the appropriate concentration measure would be from that bordering county.

We report results using this "patient-flow" weighted FTHHI measure under specification (5) in Table 5. To simplify the table, we have included only two measures (20 and 80 minute driving boundaries with travel costs).⁴⁷ Standard errors are again clustered

⁴⁷For potentially stronger identification, we used the same patient-flow weights on the instruments.

by county. Estimates of the physician concentration measure are quite similar to those reported in Table 4, however, the coefficients on the insurance concentration measure are larger in absolute value (i.e. more negative) with smaller standard errors. Specifically, for the 80-minute boundary, the estimate on HHI^{ins} is negative and statistically significant at the 5 percent level under the population-distribution instruments.

In general we find that the insurance HHI tends to be negative for those estimates that use larger physician geographic boundaries, but not the smaller geographic boundaries of 20 or 40 minutes. There are a number of possible explanations for these different findings. First, as stated previously, the insurance HHI is far from ideal, since it uses actual rather than predicted market shares. Second, we use the insurance HHI of the MSA, which may not match well with the exact geography where insurers exert market power. Third, these estimates may reveal limitations in our instruments, leaving us unable to identify the market power effects of insurers at this level of geography. Finally, it is also possible that insurer concentration has a limited effect on the average fee paid to physicians. Although we believe that the estimates presented here provide some evidence that insurers are able to exercise market power, it is clear that additional work is necessary to pin down the effects of insurance concentration.

4.1.3 Robustness checks

In the Appendix we show estimates using additional controls (i.e., physician firm size and physician per capita). The main results presented here do not qualitatively change when these additional controls are added. For the orthopedists, there is no relation between these variables and price. For cardiologists, even though the effects of physician concentration do not change when the additional controls are added, we do find a positive relationship between firm density and price and a negative relationship between firm size and price. One potential explanation for these findings is that these additional variables are potentially endogenous. For instance, physicians may be attracted to markets with higher fees, leading to a positive bias between physician per capita and price. Indeed, we find that these significant relationships disappear when we treat physician firm size and physician per capita as endogenous, and the positive relationship between physician concentration and price remains unchanged.

We also conduct additional empirical analysis to investigate the validity of our instruments. The Appendix shows the first-stage regressions under the Pop. III and Firm Dist. instrument sets. F statistics, testing the joint significance of the instruments, ranged from 14 to 32 for the physician concentration measure and from 5 to 10 for the insurance con-

centration measure. As a validity check, we collected the second-stage residuals from (5) under the firm-distribution instrument set, and ran a regression of these residuals on the population instrument set. If the residuals were highly correlated with the population-distribution instruments, this would suggest a potential bias. The residuals were not correlated ($R^2 \approx 0.001$) with the population-distribution instrument set. Standard errors were all large, the R^2 of both samples was quite low, around 0.001, and F statistics testing their joint significance were also fairly low (1.8 and 2.7 for cardiology and orthopedics, respectively).

4.2 Cross-Sectional Within-County Specification

As a second specification, we exploit cross-sectional variation in the $FTHHI$ within a county between cardiologists and orthopedists. Specifically, we will combine the cardiology and orthopedics samples and compare prices between cardiologists and orthopedists residing in the same county. As our $FTHHI$ measures are constructed at the specialty level, this specification assesses variation between different concentration levels for these two types of specialities within the same county. This exercise removes the rich between-county variation from the data with the hope of also removing unobserved factors specific to a county that may be correlated with physicians' competitive decisions. As it may be hard to identify subtle differences in competition between cardiologists and orthopedists when the market is highly competitive, we include an interaction term, D , which indicates if the $FTHHI$ is below some threshold that we will define.⁴⁸ Our specification takes the following form:

$$\ln(P_{nt}) = \beta_1 \ln(FTHHI_{jct}) + \beta_2 D_{jct} \cdot \ln(FTHHI_{jct}) + \beta_3 D_{jct} + \delta' X + \zeta_{ct} + \zeta_d + \zeta_{sev} + \zeta_j + \varepsilon_n. \quad (6)$$

where j indexes whether the physician is a cardiologist or orthopedist and we exploit within-county cross-sectional variation by including county-time fixed effects ζ_{ct} . Note that in this specification the insurance carrier concentration is not included as it is wiped out by the county-time fixed effects.

Estimates using OLS on the 80 minute $FTHHI$ (assuming travel costs) are shown in Table 6. The first column reports the estimate where we assume there is no differing effect

⁴⁸We implemented a similar interaction in the OLS within-state specification. Our results did not change for the cardiology sample. For the orthopedic sample, the effect was similar to our results in this subsection. That is the implied coefficient was smaller in more competitive markets.

Table 6: OLS Cross-Sectional Within-County Estimates

	$D = 0$	$D = 1$ if $FTHHI < \text{Median}$	$D = 1$ if $FTHHI < 75\text{th Percentile}$
Physician Market Boundary Defined by Driving Time			
	<u>Travel Costs Proportional to Travel Time</u>		
Physician FTHHI 80 Min. Boundary	0.015** (0.007)	0.027*** (0.009)	0.045*** (0.013)
D*(Physician FTHHI 80 Min. Boundary)		-0.012 (0.012)	-0.032** (0.015)
D		-0.015 (0.030)	-0.042* (0.025)

Notes: The dependent variable for all regressions is the logarithm of service price, $\ln(P_{nt})$. All regressions include the controls specified in equation (6). Standard errors are in parentheses and are clustered by county. One, two, and three asterisks indicate significance at the 10-percent, 5-percent, or 1-percent significance level, respectively. See Appendix for first-stage estimates.

between competitive and uncompetitive markets (i.e., where $D = 0$), while the second and third columns report estimates where the threshold is the median and 75th percentile of the $FTHHI$ across the entire sample, respectively. Estimates imply that relative concentration within a county determines the level of service prices. Meaning that if cardiologists (orthopedists) are relatively more concentrated than orthopedists (cardiologists) in the same market they are able to command higher prices. The specifications with the interaction indicate this effect is larger in more concentrated markets. This is likely due to either better identification in these markets or weaker effects of the difference in market power between these two specialties when the market is already competitive.⁴⁹

4.3 Panel Specification

In this section, we assess the affect of physician concentration on services prices using only time-series variation in concentration via a panel-type estimation. Specifically, instead of including state-time fixed effects, ζ_{at} , as in specification (5), we include separate county, ζ_c , and time, ζ_t , fixed effects:

⁴⁹As an alternative specification, one may allow for distinct competitive effects for cardiologists and orthopedists. The results for this alternative specification are similar to those reported in Table 6, with no significant differences between specialties.

$$\ln(P_{nt}) = \beta_1 \ln(FTHHI_{c,t-1}) + \beta_2 \ln(HHI_{m,t-1}^{ins}) + \delta'X + \zeta_c + \zeta_t + \zeta_d + \zeta_{sev} + \varepsilon_n. \quad (7)$$

Here we are removing potential omitted-variable bias specific to the county; however, this comes at the expense of removing the rich cross-sectional variation in county-level concentration within a state. As in Dafny et al. [2012], we use lagged values of concentration in order to account for the fact that service prices are set prospectively. We also performed our cross-sectional estimates using lagged values of concentration but the results did not change. However, we found that using lagged values in the panel greatly affected the precision of our estimates.

Since we are using only time-series variation, we can also exploit a similar instrumental variable as to that used in Dafny et al. [2012]. Specifically, they used the simulated change in the HHI attributable to a 1999 merger between Aetna and Prudential. As our sample covers 2005 through 2008, we cannot use variation from this merger. Instead, we create an analogous simulated change in HHI from a merger between United and Pacificare which occurred in December of 2005:

$$sim\Delta HHI_m = 2 \times United2005share_m \times Pacificare2005share_m. \quad (8)$$

To be consistent with Dafny et al. [2012], the instrument we use is $(year \geq 2007) \times sim\Delta HHI_m$ which allows for the instrument to take effect one full calendar year after the merger. One drawback of our measure is that there is not as much variation in this variable as in the variable used in the Dafny et al. [2012] study. For instance, 75 percent of counties experienced no simulated effect due to the merger. The 90th percentile change was 8 points and the maximum change was 697 points. We removed observations from Arizona and Colorado which were states where United agreed to divest. We found that removing these two states increases the precision of the estimates a great deal.

Since we are using simulated concentration as an instrument for the insurance concentration, we do not need all of the instruments used in the cross-section analysis. We use the following instrument sets:

Pop. i: $(year \geq 2007) \times sim\Delta HHI_m$, County Population

Pop. ii: $(year \geq 2007) \times sim\Delta HHI_m$, County Population, County Population Above Age 65

Firm i: $(year \geq 2007) \times sim\Delta HHI_m$, Total number of firms

Table 7: Panel Estimates

	Cardiology				Orthopedics					
	OLS	IV			OLS	IV				
		Pop. i	Pop. ii	Firm i	Firm ii	Pop. i	Pop. ii	Firm i	Firm ii	
Physician Market Boundary Defined by Driving Times										
		<u>Travel Costs Proportional to Travel Time</u>								
Lagged Physician FTHHI 20 Min. Boundary	-0.013 (0.008)	0.334 (0.312)	0.308 (0.247)	0.405 (0.309)	0.238 (0.194)	0.008 (0.007)	0.507 (0.722)	0.128 (0.127)	0.457 (0.629)	0.128 (0.127)
Lagged Insurance HHI	0.009 (0.006)	-0.186 (0.274)	-0.164 (0.224)	-0.114 (0.381)	-0.138 (0.208)	0.003 (0.003)	-0.088 (0.308)	0.066 (0.058)	-0.126 (0.346)	0.065 (0.058)
Lagged Physician FTHHI 80 Min. Boundary	0.002 (0.009)	0.223* (0.130)	0.208* (0.112)	0.218* (0.120)	0.187 (0.127)	0.011 (0.007)	0.578 (1.33)	0.094 (0.149)	0.307 (0.488)	0.162* (0.089)
Lagged Insurance HHI	0.008 (0.005)	-0.139 (0.149)	-0.122 (0.142)	-0.149 (0.251)	-0.232 (0.197)	0.002 (0.003)	-0.042 (0.487)	0.092 (0.067)	-0.250 (0.566)	-0.009 (0.071)

Notes: The dependent variable for all regressions is the logarithm of service price, $\ln(P_{nt})$. All regressions include the controls specified in equation (7). Standard errors are in parentheses and are clustered by county. One, two, and three asterisks indicate significance at the 10-percent, 5-percent, or 1-percent significance level, respectively. See Appendix for first-stage estimates.

Firm ii: $(\text{year} \geq 2007) \times \text{sim}\Delta\text{HHI}_m$, Total number of firms, Fraction of firms with less than 20 employees, Frac of firms with greater than 20 and less than 50 employees, Frac of firms with greater than 50 and less than 100 employees, Frac of firms with greater than 100 employees

where all variables except the simulated HHI are in logs and the unemployment rate is a third-order polynomial.

We report estimates in Table 7 as well as first-stage estimates in the Appendix. Again for simplicity we report results for the FTHHI measure constructed using a 20 minute and 80 minute boundary with travel costs. As in the cross-section estimates, we cluster by county. Although coefficients on the FTHHI measure are larger than in the cross section, standard errors are much larger. There were no significant estimates under the 20-minute boundary FTHHI. For the cardiology sample under the 80-minute boundary, estimates of the physician FTHHI were 0.223 and 0.208 and significant at the ten percent level for the Pop. i and Pop. ii instrument sets. The estimate was approximately the same size for the Firm i and Firm ii instrument sets. First-stage estimates shown in the Appendix also show these were regressions where instruments were strongest. For the other instrument sets, estimates were large but significant only at the 15 percent level. For the orthopedic

sample, all estimates were statistically insignificant from zero except the Firm i instrument set, with a point estimate of 0.162.

These large confidence intervals are likely due to both the small time-series horizon of our data as well as the small degree of time-series variation in our data as seen in Tables 1 and 2. The larger point estimates on the physician concentration measure may be attributable to a reduction in omitted variable bias, however, the cross-section estimates do lie in the confidence interval of the panel estimate.

5 Conclusion

The recent health care reform has altered industry incentives and spurred consolidation among health care providers. While many hope that this consolidation will lead to greater coordination and efficiency, others are concerned that it will increase bargaining leverage and ultimately harm consumers. In fact, even the two primary competition authorities in the United States, the DOJ and the FTC, appear to have starkly contrasting views on the effects of the new health care law. These differing opinions should not be surprising, especially given the scant evidence regarding the effects of consolidation in physician markets. This paper attempts to provide timely empirical evidence on this topic. Taking all the evidence together (i.e. estimates using large geographic markets versus small geographic markets; cross-sectional and panel; instrumental variable and ordinary least squares), this paper shows that physicians in concentrated markets are able to exercise market power. Linking our estimates to historical survey data discussed in Rebitzer and Vortruba [2011] implies that physician consolidation has caused about an 8 percent increase in fees over the last two decades (1988 to 2008).

These findings strongly suggest that policy makers and antitrust officials should remain wary of the potential anti-competitive effects of mergers among physicians. In addition, the estimates suggest that geographic markets could be as small as 20 minutes driving time, so that anti-trust authorities may need to focus on very localized geographic markets when considering the effects of competition. We also provide some evidence that insurers in more concentrated markets are able to negotiate lower service prices, although these estimates tend to be imprecisely estimated and less robust.

Although we believe that our estimates provide new and important insights into the role of market power in physician markets, there are a number of limitations to our study. First, we are unable to link fees to specific contracts between insurers and physicians. This is problematic, since it is well known that price discrimination occurs in health care markets

(see Sorensen (2003)). It is not clear if this limitation causes a bias in our estimates, but it likely reduces their precision. Second, this paper relies on reduced-form methods for analyzing competitive effects, which make it challenging to conduct precise counterfactual analysis. Third, unlike hospital markets where zip code level data is often available for both individuals and hospitals, in our data we only have county level information. Fourth, most of our identification occurs in the cross section, since there is little variation in market concentration during the time period of our study. Although our panel analysis is suggestive of competitive effects, the estimates are imprecise. We hope that future research is able to address the limitations of our study and provide further insight into our understanding of physician market power.

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Appendix

A Model of Physician Bargaining

Assume that each patient pays a fixed premium for an insurance contract that guarantees a minimum number of health “services,” Q , in the occurrence of an episode of illness. Physicians face the cost function $\Psi(Q)$ and marginal cost $\psi(Q)$, where the physician’s marginal cost will be an increasing function of the number of services provided (that is, $\psi'(Q) > 0$).⁵⁰ One can think of an episode of care as the time period between the initial health shock to an individual and final treatment.⁵¹ The total expenditure of treating an episode of care, TE , is thus the service price, P , times the total number of services, Q (that is, $TE = P \cdot Q$).⁵² Letting α represent the proportion of expenditures paid by the patient (a measure of the generosity of benefits), the patient’s demand for services can be represented as $D(P^{pock})$, where $P^{pock} = \alpha P$ is the out-of-pocket price.

A.0.1 Period 0

In Period 0 both insurance carriers and physician firms consider the profitability of entering different local markets. In the spirit of Bresnahan and Reiss (1991), insurance carriers and physician firms enter a market if the expected profits from entry are positive. The key components of profits include the variable profit per individual served in the market, the market size, along with a fixed entry cost. More formally, an insurance carrier enters a local market if its profit from entry is positive:

$$\pi_{ins} = M \cdot \mathbf{d}(prem, P^{pock}) \cdot [prem - \mathbf{AVC}(P^{pock}, P, Q(P^{pock}, P))] - F > 0 \quad (9)$$

⁵⁰There are several factors that may cause physician firms to have increasing marginal costs for the treatment of patients. Perhaps the most important factor is the opportunity cost of the physician’s time. The physician’s limited amount of time in a day will make it necessary to hire additional units of labor or capital as she expands the number of services provided per patient (e.g. assistants or other physicians may be added to the physician firm) which may be costly. It is also possible that physicians perceive that the probability of malpractice lawsuits or damage to their reputation are higher as more services are done that may be less beneficial to the patient. In any case, the empirical model in this paper will test this assumption. Note that if the marginal cost curve is flat, we should not expect to find an empirical relationship between the physician’s price and utilization.

⁵¹In our empirical analysis, we will cap an episode for a chronic disease at 365 days.

⁵² TE is sometimes referred to as the “episode price” in the literature.

where $\mathbf{d}(prem, P^{pock})$ represents individual insurance demand and is a function of both the premium, $prem$, and the amount paid out-of-pocket, P^{pock} . The market size covered by the insurance carrier is represented as M . The average variable cost of the insurance carrier, $\mathbf{AVC}(P^{pock}, P, Q(P^{pock}, P))$, is a function of utilization, the service price, and the out-of-pocket price. The insurance carrier's fixed cost is F .

The physician firm's entry decision is also determined by its profit function. The physician firm enters if profits are positive:

$$\pi_{phys} = m \cdot \mathbf{s}(P) \cdot [\mathbf{TE}(P, P^{pock}) - \mathbf{\Psi}(Q(P^{pock}, P))] - f > 0. \quad (10)$$

where total physician revenues are represented as $\mathbf{TE}(P, P^{pock}) = P \cdot Q(P^{pock}, P)$, physician cost, $\mathbf{\Psi}(Q(P, P^{pock}))$, is a function of utilization and the physician firm's market share is a function of the service price, $\mathbf{s}(P)$. Here, m is market size covered by the physician—the number of individuals in the physician's geographic market that are expected to have an episode. The profit per patient is the price per service, P , times the amount of services per episode, Q , minus the total cost of those services $\mathbf{\Psi}$. The physician firm's fixed cost is f .⁵³

A.0.2 Period 1

In Period 1, the service price is negotiated. To help motivate the empirical framework and explain the determinants of the negotiated service price, P^* , we present a stylized bargaining model. In this model, the service price (that is, fee schedule) will depend on negotiations between the physician group and the insurance carrier. Although fixed costs affect entry, subsequent to Period 0, the fixed costs are sunk and are no longer important in the determination of the service price. During fee negotiations, both the insurance carrier and the physician firm will be concerned with the potential set of enrollees that the physician firm would cover. The negotiation with the physician firm will affect each insurance carrier's profits in multiple ways, but here we emphasize the effects of the negotiated service price, P^* , on the average cost of the insurer serving the m potential patients. Let the insurer's variable profit function in Period 1 be:

$$\pi_{ins}^V = -\mathbf{AVC}(P^{pock}, P, Q(P^{pock}, P)) = -[1 - \alpha] \cdot \mathbf{s}(P) \cdot \mathbf{TE}(P, P^{pock}) \quad (11)$$

⁵³Note that the profit functions presented here have been simplified considerably for expositional purpose, with each physician having only a single price and single utilization level per episode. In reality, physicians treat a very heterogenous population of individuals with a variety of insurance types and health conditions, and this more detailed information will be incorporated into our empirical framework.

The physician's variable profit function in Period 1 is:

$$\pi_{phys}^V = \mathbf{s}(P) \cdot [\mathbf{TE}(P, P^{pock}) - \mathbf{\Psi}(Q(P, P^{pock}))]. \quad (12)$$

It is imperative to highlight that the measures of the potential market size, m and M , affect profitability; however, they are unlikely to have a direct effect on the negotiations between insurers and physicians, *except* through an impact on the competitive environment—determined in Period 0. To see this important concept, suppose the negotiated service price is determined by a specific bilateral Nash Bargaining problem (first proposed by Horn and Wolinsky [1988]). For simplicity, assume that the physician firm's geographic market lies within that of the insurance carrier's geographic market. It follows that the overlapping market size of the insurance carrier and the physician firm is simply m . Then, the expected impact on the profit from this population is $m \cdot \pi_{ins}^V$ for insurers and $m \cdot \pi_{phys}^V$ for physicians. In this case, each bilateral price maximizes the Nash Product of the insurer and physician profits:

$$\max_P [m \cdot \pi_{ins}^V - m \cdot \delta_{ins}]^{b_{ins}} [m \cdot \pi_{phys}^V - m \cdot \delta_{phys}]^{b_{phys}}$$

where δ_i is the disagreement payoff for either the physician firm or the insurance carrier. One may think of δ_{ins} as the expected *AVC* for a patient who is treated by the outside option (for example, the cost of a patient seeing another physician that does have a contract with the insurer). It follows that the total insurance carrier disagreement payoff is $m \cdot \delta_{ins}$. On the physician side, δ_{phys} represents the expected variable profit to the physician for treating a patient insured by the outside option (for example, the variable profit from treating patients insured by carriers that do have a contract with the physician). Similarly, the total physician disagreement payoff is $m \cdot \delta_{phys}$. Note that since both payment and disagreement amounts are proportional to m , we may write the maximization problem as

$$\max_P [m^{b_{ins}} m^{b_{phys}}] [\pi_{ins}^V - \delta_{ins}]^{b_{ins}} [\pi_{phys}^V - \delta_{phys}]^{b_{phys}}$$

Considering the first order conditions to this maximization problem, one can see that the market size information would drop out of the equation during Period 1 negotiations, so the maximization problem may be re-written as:

$$\max_P [\pi_{ins}^V - \delta_{ins}]^{b_{ins}} [\pi_{phys}^V - \delta_{phys}]^{b_{phys}} \quad (13)$$

Therefore, in this bargaining game, the market size and fixed costs do not directly enter this first period profit maximization problem. However, m , M , f , and F clearly affect

entry in Period 0, which will subsequently have an impact on this maximization problem and the negotiated price. That is, pricing decisions in the market will be related to market size and fixed costs, *only* through the effects on the competitive environment.⁵⁴

B Variable Definitions

- Concentration Measures
 - $FTHHI_{ct}$: The Fixed-Travel-Time Herfindahl-Hirschman concentration measure for physicians. This measure is specific a county and time period (half-year).
 - HHI_{mt}^{ins} : The Herfindahl-Hirschman concentration measure for insurance carriers. This measure is specific to each MSA and time period (half-year).
- Expenditure Measures
 - P_{nt} : The logarithm of price per service for episode of care n performed at time t of services performed by the physician.
 - Q_{nt} : The logarithm of service utilization for episode of care n provided by the physician.
 - TE_{nt} : The logarithm of total physician expenditures of episode of care n .
- Patient-Specific Controls (PAT)
 - $\ln(medinc_{pat})$ - The logarithm of the median income in the patient’s county.
 - $educ_{pat}$ - The fraction of college educated individuals in the patient’s county.
 - EPO - A dummy variable indicating if the patient’s health plan is an exclusive provider organization.
 - HMO - A dummy variable indicating if the patient’s health plan is a health maintenance organization.

⁵⁴A similar argument is relevant for the insurer when setting premiums and benefits, P^{pock} . Specifically, the insurer solves the maximization problem $\max_P M \cdot \mathbf{d}(\phi, P^{pock})(\phi - \mathbf{AVC}(P^{pock}, P, Q(P^{pock}, P)))$. In this optimization problem, the market size relevant to the insurer, M , and the fixed cost, F , also drop out of the first order condition.

- *POS* - A dummy variable indicating if the patient’s health plan is a point-of-service plan.
 - *PPO* - A dummy variable indicating if the patient’s health plan is a preferred provider organization.
 - *HDHP* - A dummy variable indicating if the patient’s health plan is a high-deductible health plan.
 - *CDHP* - A dummy variable indicating if the patient’s health plan is a consumer-driven health plan.
 - *EMPLOYER* - A dummy variable indicating if the patient’s health plan is employer based
 - *AGE* - The patient’s age
 - AGE^2 - The patient’s age squared
 - AGE^3 - The patient’s age cubed
 - *COMORBID* - The number of co-morbidities (that is, concurrent diseases) of the patient.
 - $COMORBID^2$ - The number of co-morbidities squared.
 - $COMORBID^3$ - The number of co-morbidities cubed.
 - *GENDER* - A dummy variable indicating the patient’s gender
- Physician Quality Controls (*QUAL*)
 - $\ln(\text{medinc}_{flow})$: The logarithm of the patient-weighted median household income. Here, $\text{medinc}_{flow} = \sum \omega_{cp} \text{medinc}_c$, where medinc_c is the median income in county c and ω_{cp} is the share of physician p ’s patients from county c . Taken from the Area Resource File.
 - *UNIV*: The fraction of hospitals in the physician’s county, c , that are affiliated with a medical university. Taken from the Area Resource File.
- Physician Cost Controls (*COST*)
 - $\ln(\text{rent}_{phys})$: The logarithm of the median gross rent in the physician’s county. Taken from the Area Resource File.
 - $\ln(\text{medval}_{phys})$: The logarithm of the median home value in the physician’s county. Taken from the Area Resource File.

- $\ln(\text{medinc}_{phys})$: The logarithm of the median household in the physician’s county. Taken from the Area Resource File.
 - $\ln(\text{facwage}_{phys})$: The logarithm of the total health care facility payrolls divided by the number of facility employees. Taken from the Area Resource File.
- Population-Distribution Instruments (Pop.)
 - $\ln(\text{pop})$ - The logarithm of county population. Taken from the Area Resource File.
 - $\ln(\text{pop65})$ - The logarithm of the county population over 65 years of age. Taken from the Area Resource File.
 - $\ln(\text{pop}K)$ - The logarithm of imputed county population between K-10 and K years of age, where $K = 65, 55, 45,$ and 35 in the Area Resource file. That is, $\text{pop}K = \text{frac}K_c * \text{pop}_c$, where $\text{frac}K$ is the fraction in K to K-10 age-group for county c in the entire MarketScan[®] database.
 - $\ln(\text{pop}_{MSA})$ - The logarithm of the population of the MSA. Taken from the Area Resource File.
 - $URATE$ - The unemployment rate in the physician’s county. Taken from the Area Resource File.
 - $URATE^2$ - The unemployment rate in the physician’s county squared. Taken from the Area Resource File.
 - $URATE^3$ - The unemployment rate in the physician’s county cubed. Taken from the Area Resource File.
 - Firm-Distribution Instruments (Firm)
 - $\ln(\text{firms})$ - The logarithm of the number of business establishments in the physician’s county c in year y . Taken from U.S. Census Bureau’s County Business Patterns database.
 - $\ln(\text{firm}20)$ - The logarithm of the fraction of business establishments with less than 20 employees in the physician’s county c in year y . Taken from U.S. Census Bureau’s County Business Patterns database.
 - $\ln(\text{firm}50)$ - The logarithm of the fraction of business establishments with greater than 20 employees and less than 50 employees in the physician’s county c in year y . Taken from U.S. Census Bureau’s County Business Patterns database.

- $\ln(firm100)$ - The logarithm of the fraction of business establishments with greater than 50 employees and less than 10 employees in the physician's county c in year y . Taken from U.S. Census Bureau's County Business Patterns database.

C Instrumental Variables Analysis

C.1 Cross-Sectional Analysis

C.1.1 First Stage Estimates: Population-Distribution Instruments (Pop. III)

	Cardiology		Orthopedics	
	$\ln(FTHHI)$	$\ln(HHI^{ins})$	$\ln(FTHHI)$	$\ln(HHI^{ins})$
Log of County Population	-0.225 (0.796)	0.532 (0.359)	1.545* (0.887)	0.288 (0.269)
Log of County Population ≥ 65	-0.348 (0.293)	-0.088 (0.077)	-0.393* (0.211)	-0.118* (0.067)
55 \leq Log of County Population < 65	0.533* (0.273)	0.033 (0.106)	-0.347 (0.284)	0.092 (0.093)
45 \leq Log of County Population < 55	-0.781* (0.394)	-0.159 (0.154)	0.062 (0.384)	-0.053 (0.129)
35 \leq Log of County Population < 45	0.587 (0.529)	-0.315 (0.249)	-0.965* (0.569)	-0.211 (0.184)
Log of MSA Population	-0.372*** (0.043)	-0.050*** (0.012)	-0.348*** (0.038)	-0.053*** (0.011)
Unemployment Rate	-3.452 (29.54)	12.33 (12.10)	24.99 (37.94)	18.18 (13.87)
Unemployment Rate Squared	-553.2 (799.4)	-542.2* (321.5)	-890.7 (1008.0)	-718.6* (369.4)
Unemployment Rate Cubed	7598.8 (6096.2)	4952.0** (2451.5)	8931.1 (7312.9)	6255.9** (2784.9)
F Statistic	23.46	6.29	18.23	8.15

Notes: The dependent variable is listed at the column head. The FTHHI is measured using an 80 minute boundary assuming travel costs. Standard errors are clustered by county. Not shown are the estimates on the covariates of specification (5). F-statistics test the null hypothesis that all instruments are jointly equal to zero.

C.1.2 First Stage Estimates: Population-Distribution Instruments (Pop. III), Patient-Flow Weighted Variables

	Cardiology		Orthopedics	
	$\ln(FTHHI)$	$\ln(HHI^{ins})$	$\ln(FTHHI)$	$\ln(HHI^{ins})$
Log of County Population	-0.334 (0.716)	0.336 (0.379)	1.600* (0.849)	0.266 (0.343)
Log of County Population ≥ 65	-0.631** (0.254)	-0.117 (0.082)	-0.549** (0.216)	-0.113 (0.079)
55 \leq Log of County Population < 65	0.589** (0.237)	0.143 (0.113)	-0.349 (0.259)	0.116 (0.103)
45 \leq Log of County Population < 55	-0.894** (0.398)	-0.172 (0.165)	0.104 (0.399)	-0.069 (0.159)
35 \leq Log of County Population < 45	0.190 (0.458)	-0.190 (0.250)	-1.061** (0.534)	-0.207 (0.220)
Log of MSA Population	-0.156*** (0.028)	-0.050*** (0.011)	-0.164*** (0.026)	-0.052*** (0.012)
Unemployment Rate	-7.706 (22.320)	11.38 (12.1)	13.815 (28.8)	18.034 (13.994)
Unemployment Rate Squared	-628.8 (599.6)	-517.7 (319.4)	-549.4 (734.6)	-715.257* (372.0)
Unemployment Rate Cubed	8510.2* (4593.0)	4814.4* (2438.9)	5483.8 (5126.8)	6224.406** (2797.5)
F Statistic	32.33	5.48	23.52	7.79

Notes: The dependent variable is listed at the column head. The FTHHI is measured using an 80 minute boundary assuming travel costs. Standard errors are clustered by county. Not shown are the estimates on the covariates of specification (5). F-statistics test the null hypothesis that all instruments are jointly equal to zero.

C.1.3 First Stage Estimates: Firm-Distribution Instruments

	Cardiology		Orthopedics	
	$\ln(FTHHI)$	$\ln(HHI^{ins})$	$\ln(FTHHI)$	$\ln(HHI^{ins})$
Log of Number of Firms in County	-0.474*** (0.057)	-0.020 (0.017)	-0.290*** (0.056)	-0.025** (0.013)
Fraction of Firms < 20 Employees	11.25* (6.707)	5.312*** (1.643)	12.9** (6.551)	5.38*** (1.310)
20 Employees \leq Fraction of Firms > 50 Employees	2.963*** (0.957)	1.022*** (0.240)	3.199*** (0.958)	0.958*** (0.193)
50 Employees \leq Fraction of Firms > 100 Employees	0.967** (0.435)	0.287** (0.124)	0.441 (0.335)	0.288*** (0.107)
F Statistic	23.85	7.37	14.98	10.5

Notes: The dependent variable is listed at the column head. The FTHHI is measured using an 80 minute boundary assuming travel costs. Standard errors are clustered by county. Not shown are the estimates on the covariates of specification (5). F-statistics test the null hypothesis that all instruments are jointly equal to zero.

C.1.4 First Stage Estimates: Firm-Distribution Instruments, Patient-Flow Weighted Variables

	Cardiology		Orthopedics	
	$\ln(FTHHI)$	$\ln(HHI^{ins})$	$\ln(FTHHI)$	$\ln(HHI^{ins})$
Log of Number of Firms in County	-0.466*** (0.040)	-0.025 (0.017)	-0.325*** (0.044)	-0.033** (0.013)
Fraction of Firms < 20 Employees	30.5*** (7.069)	7.770*** (1.929)	20.037*** (6.132)	7.449*** (1.759)
20 Employees <= Fraction of Firms > 50 Employees	4.880*** (0.873)	1.313*** (0.283)	4.076*** (0.789)	1.295*** (0.240)
50 Employees <= Fraction of Firms > 100 Employees	1.631*** (0.447)	0.333** (0.146)	0.609 (0.390)	0.290*** (0.132)
F Statistic	54.99	7.65	35.61	10.81

Notes: The dependent variable is listed at the column head. The FTHHI is measured using an 80 minute boundary assuming travel costs. Standard errors are clustered by county. Not shown are the estimates on the covariates of specification (5). F-statistics test the null hypothesis that all instruments are jointly equal to zero.

C.2 Panel Analysis

C.2.1 First Stage Estimates: Population-Distribution Instruments (Pop. i)

	Cardiology		Orthopedics	
	$\ln(FTHHI_{t-1})$	$\ln(HHI_{t-1}^{ins})$	$\ln(FTHHI_{t-1})$	$\ln(HHI_{t-1}^{ins})$
Log of Lagged County Population	-0.943*** (0.300)	-0.624* (0.368)	-0.180 (0.177)	-0.534* (0.285)
(year >= 2007) \times $sim\Delta HHI_m$	-1.002 (2.217)	11.175*** (4.094)	0.247 (3.390)	12.087** (5.363)
F Statistic	5.04	5.15	0.52	4.02

Notes: The dependent variable is listed at the column head. The FTHHI is measured using an 80 minute boundary assuming travel costs. Standard errors are clustered by county. Not shown are the estimates on the covariates of specification (7). F-statistics test the null hypothesis that all instruments are jointly equal to zero.

C.2.2 First Stage Estimates: Population-Distribution Instruments (Pop. ii)

	Cardiology		Orthopedics	
	$\ln(FTHHI_{t-1})$	$\ln(HHI_{t-1}^{ins})$	$\ln(FTHHI_{t-1})$	$\ln(HHI_{t-1}^{ins})$
Log Lagged County Population	-0.848** (0.379)	-1.259** (0.558)	-0.246 (0.251)	-1.107** (0.475)
Log Lagged County Population >= 65	-0.067 (0.335)	0.783 (0.494)	0.079 (0.283)	0.705 (0.456)
(year >= 2007) \times $sim\Delta HHI_m$	-1.101 (2.270)	11.185*** (4.126)	0.296 (3.48)	12.35** (5.54)
F Statistic	3.39	4.07	0.470	3.29

Notes: The dependent variable is listed at the column head. The FTHHI is measured using an 80 minute boundary assuming travel costs. Standard errors are clustered by county. Not shown are the

estimates on the covariates of specification (7). F-statistics test the null hypothesis that all instruments are jointly equal to zero.

C.2.3 First Stage Estimates: Firm-Distribution Instruments (Firm Dist. i)

	Cardiology		Orthopedics	
	$\ln(FTHHI_{t-1})$	$\ln(HHI_{t-1}^{ins})$	$\ln(FTHHI_{t-1})$	$\ln(HHI_{t-1}^{ins})$
Log of Lagged Number of Firms in County	-0.098 (0.213)	0.026 (0.346)	-0.099 (0.218)	-0.092 (0.306)
$(year \geq 2007) \times sim\Delta HHI_m$	-0.520 (2.265)	11.497*** (4.137)	0.337 (3.411)	12.37** (5.400)
F Statistic	0.14	3.98	0.11	2.62

Notes: The dependent variable is listed at the column head. The FTHHI is measured using an 80 minute boundary assuming travel costs. Standard errors are clustered by county. Not shown are the estimates on the covariates of specification (7). F-statistics test the null hypothesis that all instruments are jointly equal to zero.

C.2.4 First Stage Estimates: Firm-Distribution Instruments (Firm ii)

	Cardiology		Orthopedics	
	$\ln(FTHHI_{t-1})$	$\ln(HHI_{t-1}^{ins})$	$\ln(FTHHI_{t-1})$	$\ln(HHI_{t-1}^{ins})$
Log of Lagged Number of Firms in County	-0.078 (0.216)	0.033 (0.348)	-0.131 (0.212)	-0.079 (0.306)
Lagged Fraction of Firms < 20 Employees	7.134** (3.415)	5.897 (5.975)	0.052 (3.209)	3.850 (5.362)
20 Employees <= Lagged Fraction of Firms > 50 Employees	0.228 (0.411)	0.413 (0.642)	-0.232 (0.365)	0.301 (0.577)
50 Employees <= Lagged Fraction of Firms > 100 Employees	-0.013 (0.139)	0.050 (0.226)	0.136 (0.124)	-0.048 (0.195)
$(year \geq 2007) \times sim\Delta HHI_m$	-0.074 (1.911)	11.814*** (4.403)	0.305 (3.381)	12.502** (5.508)
F Statistic	2.09	1.83	1.46	1.44

Notes: The dependent variable is listed at the column head. The FTHHI is measured using an 80 minute boundary assuming travel costs. Standard errors are clustered by county. Not shown are the estimates on the covariates of specification (5). F-statistics test the null hypothesis that all instruments are jointly equal to zero.

D Robustness Exercise: Controlling for Average Firm Size and Physician Density

We provide additional estimates where we include controls for the size of the firm and the number of physicians per capita in the county. Specifically, we include a variable $\ln(scale)$ which is the logarithm of the average number of doctors per firm in county c at time t . We also include a variable $\ln(physdens)$ which is measured as the logarithm of the total number of cardiologists (or orthopedists) per capita in county c at time t .

The former variable is meant to control for possible economies of scale of larger firms, while the latter variable is meant to control for the overall supply of physicians. As these two variables may be endogenous to the extent that physicians chase higher prices, we also include specifications where we include them as endogenous right-hand-side variables, which is labeled as “endogenous controls” in the tables.

All regressions include state-halfyear and disease and stage-of-illness fixed effects. The omitted plan types are “basic medical” and “comprehensive.” Standard errors are in parentheses and are clustered by county. One, two, and three asterisks indicate significance at the 10-percent, 5-percent, or 1-percent significance level, respectively. For completeness, we also show readers estimates on the control variables. The FTHHI is measured using an 80 minute boundary assuming travel costs. OLS estimates do not instrument for any variables and are repeated in both tables for ease of comparison to the IV estimates.

D.1 Estimates Assuming $\ln(\mathit{physdens})$ and $\ln(\mathit{scale})$ are Exogenous

	Cardiology					Orthopedics				
	OLS	IV				OLS	IV			
		Pop. I	Pop. II	Pop. III	Firm Dist.		Pop. I	Pop. II	Pop. III	Firm Dist.
$\ln(\mathit{FTHHI})$	0.034*** (0.007)	0.087*** (0.028)	0.070*** (0.020)	0.076*** (0.020)	0.054*** (0.014)	0.019** (0.008)	0.051** (0.026)	0.056** (0.024)	0.060*** (0.022)	0.072** (0.028)
$\ln(\mathit{HHI}^{100})$	0.016 (0.013)	-0.393* (0.229)	-0.220 (0.187)	-0.279* (0.167)	0.010 (0.122)	0.022* (0.011)	-0.079 (0.158)	-0.109 (0.158)	-0.146 (0.136)	-0.157 (0.182)
$\ln(\mathit{physdens})$	0.023*** (0.009)	0.041** (0.016)	0.033*** (0.013)	0.036*** (0.013)	0.025*** (0.009)	0.015 (0.011)	0.025 (0.020)	0.028 (0.019)	0.031* (0.017)	0.032 (0.021)
$\ln(\mathit{scale})$	-0.013 (0.010)	-0.051** (0.023)	-0.039** (0.020)	-0.043** (0.020)	-0.030** (0.015)	0.015 (0.010)	-0.012 (0.026)	-0.016 (0.023)	-0.020 (0.022)	-0.029 (0.028)
AGE	-0.006*** (0.002)	-0.006*** (0.002)	-0.006*** (0.002)	-0.006*** (0.002)	-0.006*** (0.002)	-0.003*** (0.001)	-0.003*** (0.001)	-0.003*** (0.001)	-0.003*** (0.001)	-0.003*** (0.001)
AGE^2	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)
AGE^3	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)
GENDER	0.003*** (0.001)	0.003*** (0.001)	0.003*** (0.001)	0.003*** (0.001)	0.003*** (0.001)	-0.004*** (0.001)	-0.004*** (0.001)	-0.004*** (0.001)	-0.004*** (0.001)	-0.004*** (0.001)
COMORB	-0.003*** (0.001)	-0.003*** (0.001)	-0.003*** (0.001)	-0.003*** (0.001)	-0.003*** (0.001)	-0.003*** (0.001)	-0.003*** (0.001)	-0.003*** (0.001)	-0.003*** (0.001)	-0.003*** (0.001)
COMORB ²	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000*** (0.000)	0.000** (0.000)	0.000** (0.000)	0.000** (0.000)	0.000** (0.000)
COMORB ³	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
$\ln(\mathit{medval}_{phys})$	0.065** (0.027)	0.070** (0.029)	0.071*** (0.026)	0.070*** (0.027)	0.075*** (0.027)	0.065** (0.032)	0.074** (0.031)	0.074** (0.032)	0.072** (0.031)	0.078** (0.033)
$\ln(\mathit{rent}_{phys})$	-0.032 (0.069)	-0.075 (0.093)	-0.050 (0.083)	-0.058 (0.085)	-0.008 (0.071)	-0.105* (0.062)	-0.074 (0.072)	-0.073 (0.072)	-0.073 (0.074)	-0.056 (0.077)
$\ln(\mathit{facwage}_{phys})$	-0.003 (0.010)	-0.009 (0.015)	-0.005 (0.012)	-0.006 (0.012)	0.002 (0.011)	0.009 (0.009)	0.010 (0.010)	0.009 (0.010)	0.009 (0.011)	0.010 (0.011)
$\ln(\mathit{medinc}_{phys})$	-0.021 (0.048)	-0.064 (0.071)	-0.052 (0.056)	-0.056 (0.060)	-0.041 (0.050)	-0.030 (0.044)	-0.076 (0.063)	-0.082 (0.058)	-0.088 (0.060)	-0.105 (0.072)
$\ln(\mathit{medinc}_{pat})$	0.030*** (0.010)	0.022* (0.012)	0.026** (0.011)	0.024** (0.011)	0.030*** (0.010)	0.015* (0.009)	0.017* (0.010)	0.016* (0.010)	0.016 (0.010)	0.017 (0.010)
$\ln(\mathit{educ}_{pat})$	0.055* (0.033)	0.117** (0.055)	0.087* (0.045)	0.096** (0.045)	0.041 (0.037)	0.129*** (0.040)	0.127*** (0.040)	0.129*** (0.042)	0.133*** (0.044)	0.127*** (0.046)
EPO	-0.042*** (0.010)	-0.050*** (0.012)	-0.045*** (0.011)	-0.048*** (0.011)	-0.041*** (0.010)	-0.038*** (0.012)	-0.035*** (0.013)	-0.032*** (0.014)	-0.033** (0.014)	-0.030** (0.014)
HMO	-0.035*** (0.008)	-0.044*** (0.010)	-0.040*** (0.009)	-0.042*** (0.009)	-0.036*** (0.008)	-0.003 (0.008)	-0.004 (0.008)	-0.004 (0.008)	-0.004 (0.008)	-0.004 (0.008)
POS	-0.013** (0.006)	-0.022*** (0.008)	-0.018** (0.008)	-0.020*** (0.008)	-0.015** (0.007)	-0.000 (0.006)	-0.001 (0.007)	-0.002 (0.007)	-0.002 (0.007)	-0.002 (0.007)
PPO	0.004 (0.005)	-0.005 (0.007)	-0.001 (0.006)	-0.003 (0.006)	0.003 (0.005)	0.010** (0.004)	0.009** (0.005)	0.009** (0.004)	0.009** (0.004)	0.009* (0.005)
HDHP	-0.010 (0.015)	-0.017 (0.017)	-0.015 (0.015)	-0.014 (0.016)	-0.010 (0.015)	-0.008 (0.010)	-0.007 (0.010)	-0.008 (0.010)	-0.007 (0.010)	-0.008 (0.010)
CDHP	0.033*** (0.008)	0.028*** (0.009)	0.029*** (0.009)	0.029*** (0.009)	0.031*** (0.008)	0.039*** (0.006)	0.039*** (0.006)	0.039*** (0.006)	0.039*** (0.006)	0.039*** (0.006)
EMPLOYER	-0.002 (0.010)	0.002 (0.010)	0.001 (0.010)	0.001 (0.010)	-0.001 (0.010)	0.028*** (0.007)	0.029*** (0.007)	0.030*** (0.007)	0.030*** (0.007)	0.030*** (0.007)
$\ln(\mathit{medinc}_{flow})$	-0.006 (0.021)	0.013 (0.031)	0.015 (0.024)	0.014 (0.026)	0.028 (0.022)	0.043** (0.020)	0.079*** (0.025)	0.081*** (0.023)	0.082*** (0.024)	0.100*** (0.031)
UNIV	0.017 (0.013)	0.008 (0.025)	0.013 (0.018)	0.011 (0.020)	0.020 (0.014)	0.012 (0.013)	0.008 (0.017)	0.006 (0.016)	0.004 (0.017)	0.004 (0.018)

D.2 Estimates Assuming $\ln(\text{physdens})$ and $\ln(\text{scale})$ are Endogenous

	Cardiology					Orthopedics				
	OLS	IV				OLS	IV			
		Pop. I	Pop. II	Pop III	Firm Dist.		Pop. I	Pop. II	Pop III	Firm Dist.
$\ln(FTHHI)$	0.034*** (0.007)	0.087*** (0.029)	0.080*** (0.027)	0.081*** (0.021)	0.108 (0.149)	0.019** (0.008)	0.072* (0.037)	0.103** (0.043)	0.073*** (0.027)	0.110 (0.077)
$\ln(HHI^{ms})$	0.016 (0.013)	-0.418 (0.498)	-0.209 (0.202)	-0.230 (0.191)	-0.524 (0.772)	0.022* (0.011)	-0.302 (0.328)	-0.266 (0.264)	-0.246 (0.195)	-0.702 (0.644)
$\ln(\text{physdens})$	0.023*** (0.009)	0.044 (0.086)	0.017 (0.053)	0.030 (0.049)	0.310 (0.806)	0.015 (0.011)	0.029 (0.071)	-0.058 (0.077)	0.009 (0.056)	0.270 (0.808)
$\ln(\text{scale})$	-0.013 (0.010)	-0.038 (0.181)	-0.101 (0.090)	-0.101 (0.071)	-0.116 (0.669)	0.015 (0.010)	0.073 (0.132)	-0.061 (0.139)	0.039 (0.105)	0.068 (0.996)
AGE	-0.006*** (0.002)	-0.006*** (0.002)	-0.006*** (0.002)	-0.006*** (0.002)	-0.005 (0.005)	-0.003*** (0.001)	-0.003*** (0.001)	-0.003*** (0.001)	-0.003*** (0.001)	-0.003** (0.001)
AGE^2	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000 (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000 (0.000)
AGE^3	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000 (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000 (0.000)
GENDER	0.003*** (0.001)	0.003*** (0.001)	0.004*** (0.001)	0.004*** (0.001)	0.004 (0.004)	-0.004*** (0.001)	-0.005*** (0.001)	-0.005*** (0.001)	-0.005*** (0.001)	-0.005*** (0.001)
$COMORB$	-0.003*** (0.001)	-0.003*** (0.001)	-0.003*** (0.001)	-0.003*** (0.001)	-0.003** (0.001)	-0.003*** (0.001)	-0.003*** (0.001)	-0.003*** (0.001)	-0.003*** (0.001)	-0.004*** (0.001)
$COMORB^2$	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000*** (0.000)	0.000** (0.000)	0.000** (0.000)	0.000** (0.000)	0.000* (0.000)
$COMORB^3$	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
$\ln(\text{medval}_{phys})$	0.065** (0.027)	0.071* (0.037)	0.064** (0.026)	0.062** (0.026)	0.049 (0.149)	0.065** (0.032)	0.089** (0.043)	0.107** (0.043)	0.092** (0.040)	0.028 (0.425)
$\ln(\text{rent}_{phys})$	-0.032 (0.069)	-0.089 (0.245)	-0.002 (0.115)	-0.008 (0.113)	-0.075 (0.307)	-0.105* (0.062)	-0.094 (0.109)	-0.005 (0.122)	-0.074 (0.099)	-0.164 (0.157)
$\ln(\text{facvage}_{phys})$	-0.003 (0.010)	-0.015 (0.108)	0.024 (0.048)	0.018 (0.042)	-0.115 (0.176)	0.009 (0.009)	-0.011 (0.043)	0.035 (0.044)	0.001 (0.033)	-0.073 (0.050)
$\ln(\text{medinc}_{phys})$	-0.021 (0.048)	-0.066 (0.076)	-0.051 (0.059)	-0.051 (0.060)	-0.085 (0.131)	-0.030 (0.044)	-0.134 (0.103)	-0.157* (0.094)	-0.128 (0.078)	-0.174 (0.329)
$\ln(\text{medinc}_{pat})$	0.030*** (0.010)	0.021 (0.019)	0.027** (0.012)	0.027** (0.012)	0.028 (0.029)	0.015* (0.009)	0.015 (0.012)	0.014 (0.012)	0.015 (0.011)	0.019 (0.024)
$\ln(\text{educ}_{pat})$	0.055* (0.033)	0.116* (0.064)	0.113* (0.066)	0.105* (0.054)	-0.109 (0.492)	0.129*** (0.040)	0.130* (0.070)	0.230*** (0.085)	0.148** (0.062)	-0.041 (0.388)
EPO	-0.042*** (0.010)	-0.050*** (0.012)	-0.047*** (0.011)	-0.049*** (0.011)	-0.049 (0.031)	-0.038*** (0.012)	-0.027 (0.017)	-0.029* (0.017)	-0.029** (0.015)	-0.009 (0.025)
HMO	-0.035*** (0.008)	-0.045*** (0.016)	-0.039*** (0.009)	-0.040*** (0.009)	-0.043*** (0.013)	-0.003 (0.008)	-0.005 (0.009)	-0.003 (0.009)	-0.005 (0.009)	-0.011 (0.014)
POS	-0.013** (0.006)	-0.022** (0.009)	-0.020*** (0.007)	-0.020*** (0.007)	-0.019 (0.014)	-0.000 (0.006)	-0.004 (0.008)	-0.004 (0.007)	-0.004 (0.007)	-0.006 (0.021)
PPO	0.004 (0.005)	-0.005 (0.008)	-0.003 (0.006)	-0.003 (0.006)	-0.005 (0.021)	0.010** (0.004)	0.007 (0.005)	0.008* (0.005)	0.008* (0.005)	0.005 (0.007)
HDHP	-0.010 (0.015)	-0.017 (0.019)	-0.014 (0.016)	-0.014 (0.016)	-0.026 (0.038)	-0.008 (0.010)	-0.007 (0.011)	-0.009 (0.010)	-0.008 (0.010)	-0.007 (0.014)
CDHP	0.033*** (0.008)	0.027** (0.012)	0.030*** (0.009)	0.031*** (0.009)	0.023 (0.015)	0.039*** (0.006)	0.038*** (0.006)	0.041*** (0.007)	0.039*** (0.006)	0.035*** (0.008)
EMPLOYER	-0.002 (0.010)	0.001 (0.012)	0.003 (0.010)	0.003 (0.010)	-0.001 (0.016)	0.028*** (0.007)	0.029*** (0.008)	0.032*** (0.008)	0.029*** (0.008)	0.031 (0.024)
$\ln(\text{medinc}_{flow})$	-0.006 (0.021)	0.011 (0.040)	0.021 (0.027)	0.023 (0.027)	0.141 (0.421)	0.043** (0.020)	0.086*** (0.033)	0.087*** (0.031)	0.084*** (0.027)	0.174 (0.156)
UNIV	0.017 (0.013)	0.003 (0.084)	0.034 (0.038)	0.030 (0.033)	-0.047 (0.062)	0.012 (0.013)	-0.022 (0.053)	0.023 (0.045)	-0.009 (0.036)	-0.094 (0.067)