Insurer Market Structure as a Determinate of Physician Practice Size

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Abstract

I introduce a model to explain differences in the distribution of practice size across regions. In this model, a driver towards larger practices is increased negotiation power with insurance companies. For physicians choosing group size, I develop a theoretical concept of equilibrium and mathematically show how the market structure for physicians is impacted by market structure on the insurer side.

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1 Intro

There is currently no solid theoretical underpinning that explains variation in the distribution of physician practice size. If the story was purely one of efficiencies you could expect differences by market size, or even by specialty. Instead, what we see in the data is practice sizes of different specialties correlate strongly within metropolitan areas. However, this variation does not correspond to the size of the market.

One potential explanation is that the practice market structure is a response to the insurer market structure. Below I develop a model that capture this intuition, and show that under reasonable assumptions changes in insurer market structure should serve as an instrument for changes in practice market structure.

2 The Model

The focus of this model is understanding how doctors choose which practice to participate in, and how practices choose which doctors to include. The focus will first be on the impact of practice size on these dynamics, and second, the impact of insurer concentration on the distribution of practice size.

Physicians choose a practice to join in order to maximize utility. They receive positive utility from profit, they prefer autonomy which means there is a utility loss to increasing practice size, with a special benefit of being in a solo practice. A possible functional form for the utility doctor i receives from practicing in practice j is:

$$u_{ij} = \alpha_D \log(\pi_j) + \beta_D(n_j + 1) + \gamma_{iD} Solo_j + \varepsilon_{ij}$$

Where π_j is the profit doctor i would receive from practicing in practice j, n_j is the number of doctors in practice j (excluding the doctor), $Solo_j$ is an indicator variable capturing whether this practice is the physician practicing alone, and ε_{ij} is an error term (no distributional assumptions yet). The assumption is that $\alpha > 0$ (doctors value profits), $\beta < 0$ (doctors' value autonomy, conditional on profits) and $\gamma_{iD} > 0$ (there is a special bonus to practicing alone, but that may be doctor specific).

Doctors will choose the practice that will maximize their expected utility, however, they do not have the choice of any practice. The practice must want that doctor. Practices choose doctors to maximize average profit per doctor. Profit is:

$$\Pi_j = Q_j(P_j - C_j)$$

So profit per doctor is:

$$\pi_j = \Pi_j / n_j = \frac{Q_j(P_j - C_j)}{n_j}$$

For notational simplicity, I'm going to ignore cost below. Alternatively, this can be thought of looking at price as the average margin. The practice j will want to add doctor i if the following condition is met:

$$\frac{d\pi_j}{di} = \frac{\mathrm{P}_j}{n_j + 1}\frac{dQ_j}{di} + \frac{\mathrm{Q}_j}{n_j + 1}\frac{dP_j}{di} - \frac{P_jQ_j}{n_j(n_j + 1)} > 0$$

Will some algebra (appendix A) this condition reduces to:

$$\%\frac{dQ_j}{di} + \%\frac{dP_j}{di} > \frac{1}{n_j}$$

The percentage increase in quantity, plus the percentage increase in price needs to be greater than 1 over the number of doctors (prior to the addition of doctor i). Alternatively:

$$\mathrm{P}_j\frac{dQ_j}{di} + \mathrm{Q}_j\frac{dP_j}{di} > \frac{P_jQ_j}{n_j} \equiv AvgTR_j$$

$$\mathrm{Q}_j\frac{dP_j/di}{\mathrm{P}_j} > AvgTQ_j - \frac{dQ_j}{di}$$

The increase in total revenue from the increase in quantity plus the increase in total from the increase in price needs to be greater than average revenue per doctor.

Some Observations:

If we observe a doctor in practice k and not in practice j then the following must be true:

1) $\frac{\partial\pi_j}{\partial i} > 0 \rightarrow u_k > u_j$ for the matched practice k

This says that if the addition of the doctor would have increased average profit of practice j, it must be the case that doctor i preferred practice k (received a higher utility from practice k).

2) $u_j > u_k \rightarrow \frac{\partial\pi_j}{\partial i} < 0$ for the matched practice k

Observation two means that if the doctor prefers practice j, it must be the case that the addition of the doctor to practice j would have decreased average profit, and therefore practice j was not in doctor i's choice set.

Price – Reduced From

The price for practice j depends on many supply (number of doctors) and demand side factors (patient/population characteristics) as well as practice and insurer bargaining. A simple reduced form model a price for practice j in market m is:

$$P_{j,m} = \alpha_p MS_{j,m} + \beta_p HHI_{insurer,m} + \gamma_p MS_{j,m} * HHI_{insurer,m} + \boldsymbol{X_j}\delta_p + \boldsymbol{Y_m}\xi_p + \boldsymbol{Z_m}\chi_p + \varepsilon_{j,m}$$

Where $MS_{j,m}$ is the market share of practice j in market m, $HHI_{insurer,m}$ is the HH index on the insurer side in market m, $\boldsymbol{X_j}$ is an array of other practice specific factors, $\boldsymbol{Y_m}$ is an array of market specific demand factors and $\boldsymbol{Z_m}$ is an array of market specific supply factors. My assumption would be that $\alpha > 0$ (practices with a higher market share command a higher price), $\beta < 0$ (markets with higher insurer concentration have a lower price) and $\gamma > 0$ (the returns to size are higher when the insurer side is more concentrated).

I will show that with these equations my identifying assumption is equivalent to assuming that the addition of doctor i to practice j has no impact on other practice specific factors, market specific demand factors or market specific supply factors:

$$\frac{\partial \boldsymbol{X_j}}{\partial i} = \frac{\partial \boldsymbol{Y_m}}{\partial i} = \frac{\partial \boldsymbol{Z_m}}{\partial i} = \boldsymbol{0}$$

This is a much more plausible assumption in terms of supply side characteristics if we restrict the doctors choice set of practices to be in market. This is reasonable if we think of doctors having very high cost of switching geographies.

Price – Bargaining

The assuming that markets with higher insurer concentration have a lower price ($\gamma > 0$) is fundamental to my identifying assumptions, so I will support it more rigorously by a simple bargaining model between insurers and practices.

In this model, price (per patient) is bargained so that the insurer and the practice share a portion of the gains from trade. The gain is the difference between the value to the insurer (WTP) and the cost. For simplicity I only let WTP change with the provider's size, not the insurer's size[2]. Cost is also only a function of provider size.

Let the negotiated price paid by insurer k to provider j be modeled by:

$$P_{j,k} = \frac{e^{MS_j}}{e^{MS_j} + e^{MS_k}} \left(WTP_{j,k}(MS_j) - C_j(MS_j) \right) + C_j(MS_j)$$

The return to provider market share has two components. The increase in bargaining power and the increase in surplus (WTP-C):

[2] In reality, WTP depends on the characteristics of the insurers' patients and the composition of the network. However, as long as changes to market share are small it is reasonable to assume that these changes will not significantly impact either of these factors.

$$\frac{\partial P_{j,k}}{\partial MS_j} = \frac{e^{MS_j}}{e^{MS_j} + e^{MS_k}}\left(\frac{\partial WTP_{j,k}\left(MS_j\right)}{\partial MS_j} - \frac{\partial C_j\left(MS_j\right)}{\partial MS_j}\right) + \frac{\partial C_j\left(MS_j\right)}{\partial MS_j}$$

$$+ \frac{e^{MS_j} e^{MS_k}}{\left(e^{MS_j} + e^{MS_k}\right)^2}\left(WTP_{j,k}(MS_j) - C_j\left(MS_j\right)\right)$$

$$= \frac{e^{MS_j}}{e^{MS_j} + e^{MS_k}}\left(\frac{\partial WTP_{j,k}\left(MS_j\right)}{\partial MS_j} - \frac{\partial C_j\left(MS_j\right)}{\partial MS_j}\right) + \frac{e^{MS_k}}{e^{MS_j} + e^{MS_I}} P_{j,k} + \frac{\partial C_j\left(MS_j\right)}{\partial MS_j}$$

I want to show that an increase in insurer concentration (market share) will lead to an increase in provider concentration. To show this, I need to show that the market share will increase for larger practices.

The impact of insurer market share on nominal returns to size is not signable without knowledge of the relative market shares as there are two competing effects. The first is a negative effect. The higher insurer market share means that the take home share of that surplus will be smaller (a negative effect). The second is the impact on the share of the surplus. This will be positive.

However, it is not the nominal returns to physician market share that matter for practice size considerations but relative returns (percent increase). From the above equations characterizing a practice desiring a physician we can characterize the minimum quantity a doctor needs to add in order for a practice to want them:

$$\frac{\partial Q_j}{\partial i} > \frac{Q_j}{n_j} - \mathrm{Q}_j \frac{\partial P_j / \partial i}{\mathrm{P}_j} \implies \frac{\partial Q_j}{\partial i} > AvgQ_j - \mathrm{Q}_j \% \frac{\partial P_j}{\partial di}$$

To go from doctor to market share:

$$\implies \frac{\partial Q_j}{\partial i} > AvgQ_j - \mathrm{Q}_j \% \frac{\partial P_j}{\partial MS_j} \frac{\partial Q_j / \partial i}{Q_j}$$

$$\implies \frac{\partial Q_j}{\partial i} > AvgQ_j - \% \frac{\partial P_j}{\partial MS_j} \frac{\partial Q_j}{\partial i}$$

And solving for the minimum quantity:

$$\implies \frac{\partial Q_j}{\partial i}\left(1 + \% \frac{\partial P_j}{\partial MS_j}\right) > AvgQ_j$$

$$\implies \frac{\partial Q_j}{\partial i} > AvgQ_j / \left(1 + \% \frac{\partial P_j}{\partial MS_j}\right)$$

This is a different way of expressing the fact that the minimum increase in quantity needs to be the average group quantity, discounted by the increase in price. Ceteris paribus, a higher return to market share will lead to larger groups as that means groups will be more tolerant of low-productivity additions. Expressing the change in price as a function of market share allows us to use the above equations.

$$\% \frac{\partial P_{j,k}}{\partial MS_j} = \frac{\partial P_{j,k}/\partial MS_j}{P_{j,k}} = \frac{e^{MS_j}}{e^{MS_j} + e^{MS_k}} \frac{\partial WTP_{j,k}(MS_j)/\partial MS_j}{P_{j,k}} + \frac{e^{MS_k}}{e^{MS_j} + e^{MS_k}} P_{j,k} \frac{1}{P_{j,k}} + \frac{\partial C_j(MS_j)}{\partial MS_j} \frac{1}{P_{j,k}}$$

$$= \frac{\partial WTP_{j,k}(MS_j)/\partial MS_j}{WTP_{j,k}(MS_j) - C_j} + \frac{e^{MS_k}}{e^{MS_j} + e^{MS_k}} > 0$$

This is how market share changes price, which is key to determining whether to add the next physician to the practice. I am interested in how the return to market share is impacted by an increase in concentration.

$$\frac{\partial}{\partial MS_k} \% \frac{\partial P_{j,k}}{\partial MS_j} = \frac{\partial}{\partial MS_k} \left(\frac{\partial WTP_{j,k}(MS_j)/\partial MS_j}{WTP_{j,k}(MS_j) - C_j} + \frac{e^{MS_k}}{e^{MS_j} + e^{MS_k}} \right)$$

$$= \frac{e^{MS_j} e^{MS_k}}{\left(e^{MS_j} + e^{MS_k}\right)^2} > 0$$

An increase insurer market share (MS_k) increases the returns to size (in percent terms). This means that higher insurer concentration will make providers willing to take a bigger hits to average quantity to add doctors and will increase average physician practice concentration.

But I also need to show that an increase in insurer market share will make physicians more willing to join larger groups, as perhaps it is their preferences which are binding for the size restrictions.

Let $n_{j_2} > n_{j_1}$. What matters is the differences in utility:

$$u_{i,j_1} = \alpha_D \log\left(\pi_{j_1}\right) + \beta_D \, \mathrm{f}(n_{j_1}) + \gamma_{iD} Solo_{j_1} + \varepsilon_{ij}$$

$$u_{i,j_2} = \alpha_D \log\left(\pi_{j_2}\right) + \beta_D \, \mathrm{f}(n_{j_2}) + \gamma_{iD} Solo_{j_2} + \varepsilon_{ij}$$

Prefers if: $u_{i,j_2} > u_{i,j_1}$.

$$\alpha_D \log\left(\pi_{j_2}\right) + \beta_D \, \mathrm{f}(n_{j_2}) + \gamma_{iD} Solo_{j_2} + \varepsilon_{ij} > \alpha_D \log\left(\pi_{j_1}\right) + \beta_D \, \mathrm{f}(n_{j_1}) + \gamma_{iD} Solo_{j_1} + \varepsilon_{ij}$$

We are interested in how this changes with insurer concentration. All that immediately changes is π.

$$\log\left(\% \frac{\partial P_{j_2,k}}{\partial MS_k} \pi_{j_2}\right) > \log\left(\% \frac{\partial P_{j_1,k}}{\partial MS_k} \pi_{j_1}\right)$$

For there to be a change towards larger providers if:

$$\% \frac{\partial P_{j_2,k}}{\partial MS_k} > \% \frac{\partial P_{j_1,k}}{\partial MS_k}$$

Which is true because as shown above

$$\frac{\partial}{\partial MS_j} \% \frac{\partial P_{j_2,k}}{\partial MS_k} > 0$$

Quantity

Quantity of the practice is a function of the number of doctors (with diminishing marginal returns) and other practice specific factors:

$$Q_j = f(n_j) + \boldsymbol{X_j} \delta_Q + \boldsymbol{Y_m} \xi_Q + \boldsymbol{Z_m} \chi_Q + \varepsilon_j$$

Where n_j is the number of doctors, $\boldsymbol{X_j}$ is an array of other practice specific factors, $\boldsymbol{Y_m}$ is an array of market specific demand factors and $\boldsymbol{Z_m}$ is an array of market specific supply factors.

Impact of Insurer Concentration

Using the functional form assumptions on price:

$$\frac{\partial P_j}{\partial HHI_{insurer}} = \beta_p + \gamma_p MS_j$$

The higher insurer concentration decreases prices over all, but increases the return to higher market share:

$$\frac{d^2 P_j}{dn_j dHHI_{insurer}} = \gamma_P \frac{\partial MS_j}{\partial n_j} > 0$$

because adding doctors increases quantity and market share (assumption above was $\frac{\partial Q_j}{\partial n_j} > 0$). To see how this impacts the market structure recall that the condition for wanting to drop a doctor is:

$$\% \frac{dP_j}{di} - \frac{1}{n_j} < \% \frac{dQ_j}{di}$$

What changed is the percent increase in price from adding a doctor. Price went down, and the return to size went up, both effects increasing $\% \frac{dP_j}{di}$. This increase is larger for larger practices. Intuitively, larger practices can now "afford/justify" hire doctors who add less to productivity. Even if they may not want to add doctors with less marginal product in terms of quantity (sharing their profits with less productive docs), but they need to for bargaining power in order to get the increase in price.

As a note, if the premium put on having a solo practice is high enough, the change in price structure from an increase in insurer concentration may have little impact on solo-practitioners while still leading to larger groups (conditional on being in a group practice). Something similar has been observed in the data (see Burns, Goldsmith Sen "Horizontal and Vertical Integration of Physicians: A Tale of Two Tails" (2013)).

3 Appendix A - Simulations

In order to see if this model made any sense whatsoever I created some simulated markets and mergers. I created a market with 100 doctors and four insurers with varying market shares. Doctors had the following utility.

$$u_{ij} = \alpha_D \log(\pi_j) + \beta_D(n_j + 1) + \gamma_{iD} Solo_j + \varepsilon_{ij}$$

I set $\gamma_{iD} = \varepsilon_{ij} = 0$, and divided by $\beta_D = 1$ to get a function with one parameter:

$$\frac{u_{ij}}{\beta_D} = \frac{\alpha_D}{\beta_D} \log(\pi_j) - (n_j + 1)$$

I calibrated by choosing α_D/β_D so there would be 5 practices with 20 doctors each for the first simulations and then choose α_D/β_D to have 10 practices each with 10 doctors for the next simulations. I was interested to see what would happen to practice size when insurers merged. I let cost be zero, and let willingness-to-pay as constant (to focus on only the bargaining returns, and because in my model the cross-partial is zero). I then could calculate the total revenue and utility for each practice size (0-100). I experimented with including returns to willingness-to-pay with practice size, diminishing marginal productivity of doctors[3] but decided to keep it simplest.

To put doctors into practices, I had as many as possible form into the practice size that provided the highest utility. Because average practice revenue per doctor is increasing in the number of doctors, there were no size constraints on the practice size. I put the remaining doctors in a practice together.[4] The results follow.

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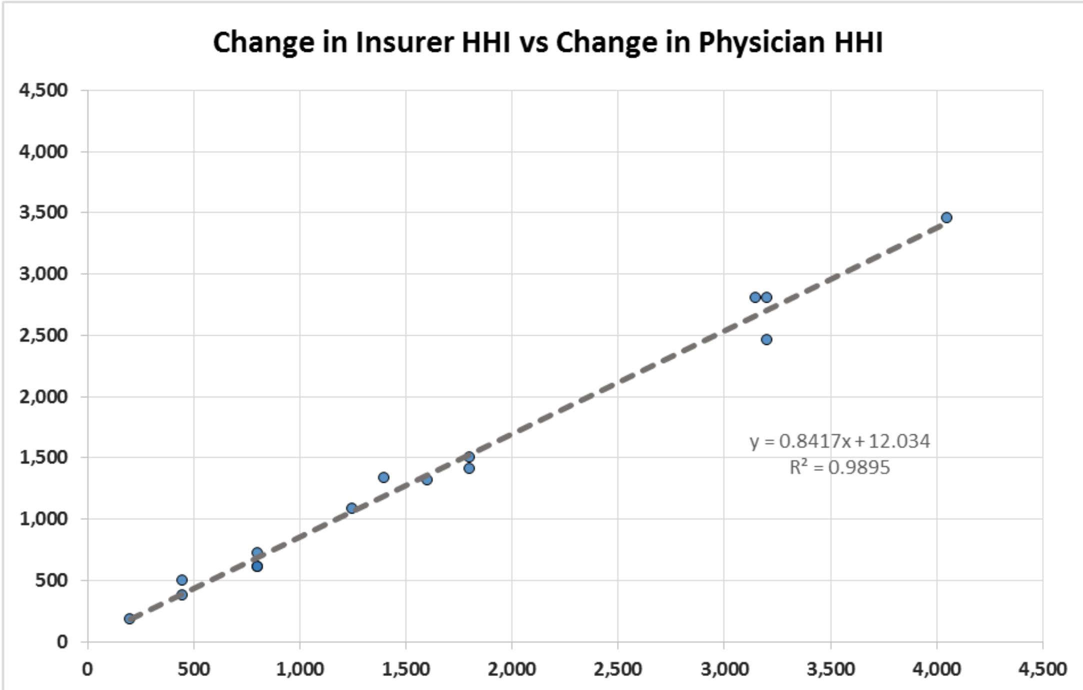
[3] This can either be thought of as doctor heterogeneity in productivity, or that the addition of doctors leads to an increase shirking and decrease in average productivity for everyone.

[4] This actually points out a peculiarity in my model. The practice will want to add physicians even though it will decrease the participating physicians' utility. I could either adjust my model (which would make it much messier), or perhaps for the simulation instead of putting the remaining doctors in a separate practice, I could distribute them across the practices.



In these simulations, the correlation between the change in insurer HHI and physician HHI is 99.5%.

	Insurer Market Share				Merged	Physician Practice Equilibrium		HHI Insurer		HHI Physician		HHI Change	
SimID	1	2	3	4	(3&4)	Pre	Post	Pre	Post	Pre	Post	Insurer	Physician
1	20%	20%	30%	30%	60%	5 practices w/20	2 practices w/37, one w/26	2,600	4,400	2,000	3,414	1,800	1,414
2	30%	30%	20%	20%	40%	5 practices w/20	3 practices w/28, one w/16	2,600	3,400	2,000	2,608	800	608
3	10%	10%	40%	40%	80%	5 practices w/20	2 practices w/49, one w/2	3,400	6,600	2,000	4,806	3,200	2,806
4	25%	25%	40%	10%	50%	5 practices w/20	3 practices w/28, one w/16	2,950	3,750	2,000	2,608	800	608
5	40%	40%	10%	10%	20%	5 practices w/20	4 practices w/23, one w/8	3,400	3,600	2,000	2,180	200	180
6	25%	25%	25%	25%	50%	5 practices w/20	3 practices w/32, one w/4	2,500	3,750	2,000	3,088	1,250	1,088
7	10%	10%	70%	10%	80%	5 practices w/20	2 practices w/34, one w/32	5,200	6,600	2,000	3,336	1,400	1,336
8	10%	10%	45%	35%	80%	5 practices w/20	2 practices w/49, one w/2	3,450	6,600	2,000	4,806	3,150	2,806
9	35%	35%	15%	15%	30%	5 practices w/20	4 practices w/25	2,900	3,350	2,000	2,500	450	500
10	35%	35%	15%	15%	30%	10 practices w/10	7 practices w/14, one w/2	2,900	3,350	1,000	1,376	450	376
11	30%	30%	20%	20%	40%	10 practices w/10	5 practices w/18, one w/10	2,600	3,400	1,000	1,720	800	720
12	20%	20%	30%	30%	60%	10 practices w/10	4 practices w/25	2,600	4,400	1,000	2,500	1,800	1,500
13	10%	10%	40%	40%	80%	10 practices w/10	2 practices w/38, one w/24	3,400	6,600	1,000	3,464	3,200	2,464
14	5%	5%	45%	45%	90%	10 practices w/10	2 practices w/47, one w/6	4,100	8,150	1,000	4,454	4,050	3,454
15	20%	20%	40%	20%	60%	10 practices w/10	4 practices w/24, one w/4	2,800	4,400	1,000	2,320	1,600	1,320