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Entry and Competition in Local Hospital Markets

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Abstract

There has been considerable consolidation in the hospital industry in recent years. Over 900 deals occurred from 1994-2000, and many local markets, even in large urban areas, have been reduced to monopolies, duopolies or triopolies. This surge in consolidation has led to concern about its effect on competition in local markets for hospital services. In this paper we examine the impact of market structure on competition in local hospital markets – specifically, does competition increase with the number of firms? We extend the entry model developed by Bresnahan and Reiss to make use of quantity information and apply it to data on the US hospital industry. The results from the estimation are striking. In the hospital markets we examine, entry leads to markets quickly becoming competitive. Entry reduces variable profits and increases quality. Indeed, most of the effects of entry come from having a second and possibly a third firm enter the market. The use of quantity information allows us to infer that entry is welfare increasing.

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1 Introduction

Throughout the United States, consolidation in the hospital industry is altering the local market structure for hospital services. During the second half of the 1990s, a wave of hospital consolidation occurred in the United States. One source puts the total number of hospital mergers from 1994-2000 at over 900 deals (Jaklevic, 2002, and www.levinassociates.com), on a base of approximately 6,100 hospitals. Many of these mergers have occurred in small markets, thereby resulting in merger for monopoly. Even some very large urban markets such as Boston, Minneapolis, and San Francisco are now dominated by 2 to 3 large hospital systems. Not surprisingly, many health plans have complained about rising prices as a result of these consolidations (Lesser and Ginsburg, 2001).

This surge in consolidation activity has led to concern about the impacts of this consolidation on competition in local markets for hospital services. The federal antitrust enforcement agencies have brought challenges in a number of cases against hospitals seeking to merge. The courts, however, have ruled against the antitrust enforcement agencies on every hospital merger case tried in the last decade (Gaynor and Vogt, 2000).

There have been a number of studies which have examined the relationship between hospital market structure and performance (e.g., Dranove et al., 1993; Connor et al., 1998; Krishnan, 2001; Dranove and Ludwick, 1999). The vast majority of these studies find a positive association between concentration and price or price-cost margins.[1] There have also been a smaller number of studies which examine the relationship between concentration and hospital quality or service offerings (e.g., Dranove et al., 1992; Kessler and McClellan, 2000; Volpp and Waldfogel, 2000). There is no clear pattern in the results of these studies: some find that concentration is associated with lower quality, while others do not.

While these studies have proven very valuable by uncovering consistent patterns in the data, they are subject to the usual criticism that it is very hard to know if "Structure-

[1] For exceptions see Lynk (1995); Lynk and Neumann (1999).

Conduct-Performance" (SCP) studies identify competition (Schmalensee, 1989; Bresnahan, 1989; Gaynor and Vogt, 2000). Bresnahan and Reiss (1991) have developed a method for examining the impact of market structure on competition that is not subject to the problems associated with the SCP approach.[2] The Bresnahan and Reiss (BR) method uses a simple, general entry condition to model market structure. The intuition is that if the population (per-firm) required to support a given number of firms in a market grows with the number of firms then competition must be getting tougher, thereby shrinking profit margins and requiring a larger population to generate the variable profits necessary to cover entry costs. Thus, the key data for this method are market structure and population, which are commonly available and accurately measured.

In particular, the BR method does not require data on price-cost margins or on prices. The former are commonly considered to be subject to biased measurement. Measured prices will also be biased in industries where list prices do not represent transaction prices. This is particularly true for the hospital industry, where insurance companies negotiate substantial discounts from list prices (called "charges"). This is also true in some other industries, such as automobiles.[3]

In this paper we augment the BR approach to take advantage of quantity data, and apply it to local markets for hospital services. This augmented approach takes advantage of the additional information contained in quantity, without imposing restrictions significantly beyond those implied by the original approach. Further, it allows for qualitative welfare inference. If quantity increases with entry, consumers are clearly better off. If the entry of an additional firm is not accompanied by any increase in quantity, however, then it cannot be social welfare enhancing, since it carries with it additional fixed costs (Berry and Waldfogel, 1999; Mankiw and Whinston, 1986). Our approach allows us to test for whether entry

[2] Two such issues include the endogeneity of market structure measures and mismeasurement of prices and price-cost margins.

[3] An alternative approach to the BR method which avoids the problems associated with SCP is structural modeling of demand and price setting by firms (Bresnahan, 1989; Berry et al., 1998). This approach requires more assumptions to put the necessary structure on the problem. It also does not readily lend itself to an examination of the relation between market structure and competition.

benefits consumers or is purely wasteful.[4] This approach extends the empirical literature in industrial organization on evaluating the determinants and effects of entry[5] by adding to the relatively scarce empirical evidence and proposing a simple extension of the BR method for industries that possess good quantity data.[6]

The results from the estimation are striking. In the hospital markets we examine, entry leads to markets becoming competitive quickly. Indeed, most of the effects of entry come from having a second and possibly a third firm enter the market. The entry of subsequent firms has relatively little additional impact.

We lay out the model and econometrics in Section 2. Section 3 contains a description of the data. The empirical results are presented in Section 4, and Section 5 contains a summary and conclusions.

2 Model and Econometrics

The model below is based on the entry model of Bresnahan and Reiss (1991). Their model uses the concept of entry thresholds — the market sizes necessary to support successive entrants to a market — to infer how the toughness of competition varies with market structure. We integrate an analysis of the quantity transacted in the market with their framework, which permits a sharper inference on the effects of structure on competition.

2.1 Demand and Costs

Hospitals are multi-product firms that provide multiple distinct services (e.g., obstetrics and cardiac treatment). However, for this analysis, we take the output of hospital production to be a single product which is the composite of the set of all hospital services. Since most

[4]We cannot test for socially inefficient entry in general. That requires evaluating the benefits of increased quantity from entry against the fixed costs. To do so would require the use of price data – precisely what we are trying to avoid.

[5]See, for example, Bresnahan and Reiss (1991); Berry (1992); Berry and Waldfogel (1999); Scott Morton (1999); Davis (2002).

[6]It should also be possible to use a similar method for industries with good data on price, but not quantity.

hospitals sell a common bundle of services (e.g., most hospitals offer obstetrics, surgery, emergency care, etc.), this assumption does capture an important aspect of institutional reality.[7] Further, because of the importance of joint costs in the hospital industry, it is not clear that it is possible to analyze entry for individual services in a meaningful way.[8]

In our model the product may be vertically differentiated, but is not horizontally differentiated. That is, we are assuming that hospitals may differ in the quality of their care, but that consumers do not differ in the way they value quality.

Thus, let market demand for hospital services be defined as:

$$Q = d(P, Z, X) \cdot S(Y). \tag{1}$$

Market demand is the product of per capita demand (the demand of a representative consumer, $d(\cdot)$) and the total market size, $S(Y)$. Per capita demand is affected by price, P, quality, Z, and exogenous demand shifters such as demographic factors and health insurance coverage, X. We presume that consumers or health insurers acting as their agents care about the price of hospital services. There is ample evidence on this point (Manning et al., 1987; Feldman and Dowd, 1986). Consumers also care about quality. Demographic factors (e.g., age) are known to affect the demand for hospital care, as is income. The market size, S, is an increasing function of population and other variables, Y.

For brevity of presentation, we assume that hospital costs are characterized by a constant average variable cost, $AVC(Z, W)$, and a fixed (or sunk) cost, $F(Z, W)$, depending upon quality, Z, and cost-shifters, W.[9]

[7] The majority of buyers of hospital services are managed care insurance plans, which purchase a bundle of hospital services for their enrollees. This assumption is nearly universally used in economic and antitrust analyses of the hospital industry (see Dranove and White, 1994; Gaynor and Vogt, 2000).

[8] For an exception, however, see Dranove et al. (1992).

[9] The assumption of constant average variable costs is not restrictive. Inferences from this model regarding conduct are unchanged even with U-shaped average costs (see Bresnahan and Reiss, 1991, 1988).

2.2 Equilibrium in Price and Quality

Through a process we do not model explicitly, a symmetric equilibrium in price and quality is reached in each market. For a market with N firms, we will denote these equilibrium values P_N, Z_N. They depend upon demand and cost conditions as well as the toughness of competition, represented here by θ_N:[10]

$$P_N = P(X, W, \theta_N) \tag{2}$$

$$Z_N = Z(X, W, \theta_N) \tag{3}$$

These equilibrium values of P and Z induce equilibrium values of quantity, fixed costs, and variable profits:

$$d_N = d(P_N, Z_N, X) \tag{4}$$

$$F_N = F(Z_N, W, N) \tag{5}$$

$$V_N = P_N - AVC(Z_N, W) \tag{6}$$

Following Bresnahan and Reiss (1991), we also allow fixed costs to depend directly on N, reflecting perhaps the existence of a scarce resource like a desirable location or a pool of entrepreneurs with heterogeneous geographic preferences, so that the fixed costs of entry may be higher for later entrants. As we will see below, allowing this direct dependency makes it impossible to infer the toughness of competition from entry thresholds absent some additional assumption.

[10] Tougher competition with more competitors is a robust prediction of theoretical oligopoly models (Sutton, 1991; Bresnahan and Reiss, 1991).

2.3 Entry

A hospital will enter a local market if it can earn non-negative profits. The Nth firm in a market earns profits equal to:

$$\Pi_N = (P_N - AVC_N)) \frac{S}{N} d_N - F_N \tag{7}$$

Here, AVC_N is the average variable cost induced by the equilibrium quality Z_N.

The minimum market size necessary to support N firms in the market, S_N, is derived by solving the zero-profit condition ($\Pi(S_N) = 0$). The per-firm minimum market size is:

$$s_N = \frac{S_N}{N} = \frac{F_N}{(P_N - AVC_N) d_N} \tag{8}$$

The per-firm entry threshold for N firms, s_N, is the ratio of equilibrium fixed costs to the product of equilibrium variable profits and equilibrium per-capita demand. Following Bresnahan and Reiss, we examine ratios of entry thresholds to measure the rate at which variable profits fall with entry.

$$\frac{s_{N+1}}{s_N} = \frac{F_{N+1}}{F_N} \frac{(P_N - AVC_N)}{(P_{N+1} - AVC_{N+1})} \frac{d_N}{d_{N+1}} \tag{9}$$

The entry threshold ratio, s_{N+1}/s_N, measures the product of two things: the change in fixed costs as N increases and the change in per-capita variable profits as N increases. The change in variable profits may be further decomposed into the change in per-capita quantity transacted and average variable profit. If competition is becoming tougher with entry, $\frac{d_{N+1}}{d_N}$ should be greater than one and $\frac{P_{N+1} - AVC_{N+1}}{P_N - AVC_N}$ less than one (with P_N falling or Z_N rising with rising N).

Discounting for the moment the potential for changing fixed costs, a threshold ratio of one represents an unchanging level of competition, while a threshold ratio greater than one represents an increase in the toughness of competition. Bresnahan and Reiss (1991) interpret a ratio $s_{N+1}/s_N \searrow 1$ as $N \to \infty$ as most naturally reflecting a market converging to the (unchanging) competitive equilibrium as the number of firms increases.

As equation 9 makes clear, the entry threshold ratios alone cannot separately identify the effect of entry on the toughness of price competition and the effect of entry on fixed costs.[11] Our addition to the Bresnahan and Reiss (1991) framework is the use of information on quantity transacted to separately identify the quantity effect, d_{N+1}/d_N.

2.4 Econometrics

We observe the number of firms (N) and quantity (Q) for each market, so we seek equations for both N and Q from our theory. The model thus consists of the following two equations:

$$\Pi_N = \frac{1}{N} S d_N V_N - F_N + \epsilon \tag{10}$$

$$Q_N = S d_N + \nu \tag{11}$$

Recall, however, that market size (S) is a function of population (Y). Per-capita demand (d_N) and variable profits (V_N) are functions of equilibrium price and quality (P_N, Z_N), and fixed costs (F_N) are a function of equilibrium quality. Both equilibrium price and quality are functions of demand shifters (X), cost shifters (W), and the toughness of competition (θ_N). However, we do not observe P, Z, or θ. We therefore express d_N, V_N, and F_N as reduced form functions of the observables X and W. We capture θ_N, how the toughness of competition changes with the number of firms, flexibly and non-parametrically via sums of indicators of the number of firms in the market. These enter the equations for d_N, V_N, and F_N as $\sum_{n=1}^{N}(\delta_n)^2$, $\sum_{n=1}^{N}(\alpha_n)^2$, and $\sum_{n=1}^{N}(\gamma_n)^2$. Notice that these sums are cumulative, so that, for example, $(\delta_3)^2$ represents the marginal increase in per-capita quantity brought

[11] Notice that, like Bresnahan and Reiss (1991), we can separate average variable profit from fixed costs only through a functional form assumption (specifically, the error term in the profit equation in the econometric model enters additively).

about by entry of the third firm, relative to the per-capita quantity of a two-firm market. The terms are squared simply to avoid the estimation returning negative parameter estimates.

The econometric model therefore also includes the following four equations:

$$S = Y\lambda \tag{12}$$

$$d_N = X\delta_X + W\delta_W + \sum_{n=1}^{N} (\delta_N)^2 + \eta \tag{13}$$

$$V_N = X\alpha_X + W\alpha_W - \sum_{n=1}^{N} (\alpha_N)^2 + \beta\eta \tag{14}$$

$$F_N = W\gamma_W + \sum_{n=1}^{N} (\gamma_N)^2 \tag{15}$$

We model the profit equation error, ϵ, and the quantity error, ν, as independent normals. Each has zero mean and constant variance, with σ_ϵ normalized to one. We think of ϵ as representing unmodelled differences in fixed costs across markets and ν representing transient demand shocks, explaining its absence from equation 10.

Correlation between the two equations enters through η, which we assume is independent of the other errors. This error may represent unmodelled shifters of per-capita demand or of variable costs (in which case the parameter $\beta > 0$) or it may represent heterogeneity across markets in θ, the toughness of price competition, controlling for N (in which case $\beta < 0$). Of course, η may contain elements of both, in which case the sign of β merely tells us which of the two effects dominates.

The inclusion of a non-degenerate η in the model creates a selection effect. Suppose that the unobserved factors in η are demand-shifters. Then markets with higher than average η will have both higher than average per-capita quantity and a higher than average number of firms. But this association will occur for reasons unrelated to competition. Similarly, if markets vary in the toughness of competition, high-η markets will have high quantity and low numbers of firms.

Writing $V_N(\eta)$ and $d_N(\eta)$ for emphasis, consider the contribution to the likelihood function, conditional on η, of an observation with $N \geq 1$ firms and a quantity Q:

$$\frac{1}{\sigma_\nu}\phi\left(\frac{1}{\sigma_\nu}\left(Q - Sd_N(\eta)\right)\right)\cdot \\ \left[\Phi\left(F_N - \frac{1}{N}SV_N(\eta)d_N(\eta)\right) - \Phi\left(F_{N+1} - \frac{1}{N+1}SV_{N+1}(\eta)d_{N+1}(\eta)\right)\right] \tag{16}$$

To arrive at the unconditional contribution to the likelihood function, we must integrate over η, and this requires choosing a distribution for η. Rather than assuming a particular functional form for the distribution of η, we choose to approximate this distribution using a discrete factor approximation (Heckman and Singer, 1984; Mroz and Guilkey, 1992). Specifically, let the distribution of η with K points of support be:

$$P\left\{\eta = \mu_k\right\} = p_k \qquad k = 1, \ldots, K \tag{17}$$

$$p_k \geq 0\ \forall k, \qquad \sum p_k = 1, \qquad \sum p_k \mu_k = 0$$

A typical term of the likelihood function is then:

$$\sum_{k=1}^{K} p_k \frac{1}{\sigma_\nu}\phi\left(\frac{1}{\sigma_\nu}\left(Q - Sd_N(\mu_k)\right)\right)\cdot \\ \left[\Phi\left(F_N - \frac{1}{N}SV_N(\mu_k)d_N(\mu_k)\right) - \Phi\left(F_{N+1} - \frac{1}{N+1}SV_{N+1}(\mu_k)d_{N+1}(\mu_k)\right)\right] \tag{18}$$

The p and μ then become parameters to estimate and K is increased until the likelihood function no longer increases appreciably.

3 Data

3.1 Market Definition

The unit of analysis is a market for hospital services. Markets for hospital services are local, owing to the nature of the service (Frech, 1987). There is no single, agreed upon method for empirical market definition, although it is clear that the markets should be "self-contained" in the sense that there is not relevant competition from outside the market. We thus follow Bresnahan and Reiss by focusing on geographically isolated markets as a way of minimizing the possibility of competition coming from outside the defined market.

With that in mind, we define our markets using the following selection criteria. First, we identified all cities and census designated places (CDPs) in the United States with populations of at least 5,000, using the 1990 Census. This we designate as a potential market. Second, to reduce the possibility of market overlap, we eliminate potential markets that are within 50 miles of a city with a population of at least 100,000, or within 15 miles of another potential market. Third, we eliminate all potential markets in which a hospital was located outside of the city but within 15 miles. Finally, markets that were on Indian reservations or located in Alaska or Hawaii were excluded from the analysis. Applying these criteria, we identify 613 markets with 490 hospitals. Figure 1 contains a map illustrating the locations of these markets.

As a check of our market definition, we include in our regressions the natural log of the distance from a hospital market to the nearest city with a population of at least 100,000, as well as the natural log of the distance from a hospital market to the nearest city with a population of at least 5,000. These variables should pick up "leakages" to or from nearby locations.

3.2 Data and Measures

3.2.1 Sources

We use data from a variety of sources, including the American Hospital Association (American Hospital Association, 1990), the 1990 U.S. Census, the Area Resource File (Bureau of Health Professions, 1996), the InterStudy National HMO Census (InterStudy, 1990), and the Missouri Certificate of Need Program (Piper, 1998).

3.2.2 The Number of Firms, N

The number of firms is defined as the total number of short-term general hospitals with 50 or more beds in a local market. We eliminate any hospitals with fewer than 50 beds on the grounds that they are not effectively full service hospitals. Military hospitals are also excluded, since they do not serve the general public. We identified hospitals and their location from the American Hospital Association (American Hospital Association, 1990). Table 1 contains the distribution of hospital market structures and their average populations in our sample.

3.2.3 Quantity, Q

The measure we use for quantity is total adjusted admissions in the market.[12] These data come from the American Hospital Association, which collects this information from all hospitals in the U.S. on an annual basis (American Hospital Association, 1990). Adjusted admissions allow for the fact that hospitals provide both inpatient and outpatient care by creating a weighted average of the two, where the weight for inpatient admissions is 1 and for outpatient visits is the ratio of outpatient charges per visit to inpatient charges per admission. There are other commonly used measures of hospital quantity, such as inpatient admissions alone, inpatient hospital days, or hospital beds. We examined the correlations

[12] For short-term general non-military hospitals.

between all pairs of these measures. Each correlation was greater than 0.9.

3.2.4 Market Size, S(Y)

Population, Y, is the key determinant of market size, S. We use data from the 1990 Census on the population of the places that are markets in our sample. Population means by market structure are contained in Table 1. The mean population size for the entire sample is 19,102.

Using population of the place may not accurately represent the total population of the market if individuals living outside the place travel there to obtain hospital services. To control for potential inflows, we include a measure of the market fringe population, defined as the population located outside the place, but within 15 miles. In contrast, some residents of the place may choose to travel outside of the local market to obtain hospital services. We proxy for this potential outflow by including the proportion of residents who commute more than 45 minutes to work. Assuming this measure is correlated with residents' willingness to travel to obtain care elsewhere, this should be associated with a decrease in the demand for hospital services in the market.

Last, we also include an indicator variable for whether the market has a military base. Since military personnel may obtain health care from military facilities, demand may be lower in an area with a military base than in an otherwise similar area without one.[13]

3.2.5 Demand Shifters, X

Referring back to equations (13) and (14), per capita demand, d_N, and variable profits, V_N, are determined in part by exogenous demand shifters, X, such as demographic factors, income, and insurance. Data for these variables come from the 1990 Area Resource File (Bureau of Health Professions, 1996). The major demographic factor is age. The proportion of the population 65 years of age and older in the market should be positively associated with demand for hospital services. Illness increases with age, and thus demand for health care.

[13] Recall that military hospitals are excluded from the count of hospitals and from the measure of quantity.

This population is also eligible to receive Medicare, thereby increasing insurance coverage and hence demand. The measure of income we use is per capita income for the area population. This may not only capture the direct effects of income on demand, but the extent of health insurance coverage in the population, since insurance coverage is positively associated with income.

We also include the number of health maintenance organizations (HMOs) as a factor affecting demand. HMOs have two effects on demand. First, HMOs attempt directly to control the amount and type of health care use, specifically focusing on keeping patients out of the hospital, directly reducing demand for hospital services. Second, HMOs often contract with a subset of hospitals in a market to provide services for their enrolled population, making choices based in large part on price. This leads to hospitals facing more elastic demand for their services. We use the number of HMOs operating in the county of the market in 1990 (InterStudy, 1990).[14]

3.2.6 Cost Shifters, W

Both variable profits (14) and fixed costs (15) are affected by exogenous cost shifters, W. Hospitals utilize various labor inputs in the provision of acute care. We use the Centers for Medicare and Medicaid Services' (CMS) hospital wage index as a measure of hospitals' labor costs.[15] We also include median gross rent, defined to be the median rent paid by renter-occupied housing units in the market, and CMS's area construction cost index to control for differences across markets in facility or building costs.[16] In addition to labor and facility costs, hospitals may incur costs associated with regulatory compliance. The National Health Planning and Resources Development Act of 1974 mandated that states establish "certificate of need" (CON) programs (Joskow, 1981). These programs require hospitals and other health care providers to obtain formal approval before making large capital investments, which

[14] We thank Doug Wholey for providing us with these data.

[15] This wage index was developed for the purposes of Medicare hospital payment. CMS is the U.S. government agency which runs Medicare.

[16] The CMS construction cost index was also developed for the purposes of Medicare hospital payment.

include the construction of new hospitals and expansion of existing facilities (Phelps, 1997). We interpret this regulation as a fixed cost that hospitals incur when choosing to enter a market. Our binary measure for the presence of a certificate of need program is CON.

Table 2 contains variable definitions and descriptive statistics.

4 Results

Table 3 contains the parameter estimates. The model was estimated with five points of support for the discrete factor approximation. The estimates are organized by impacts of variables on market size, variable profits, per capita demand, and fixed costs. Estimates of the elements of the discrete factor approximation are also reported.[17]

4.1 Parameter Estimates

The parameter estimates are largely reasonable. Fringe population affects demand 68% as strongly as does market population. Thus, as one would expect, the population outside a place affects demand, but not as strongly as population in the place itself.[18] The presence of a military base has a small but statistically insignificant impact on demand.

Average variable profits are positively and significantly affected by the proportion of the population over 65 and negatively by income per capita. Median gross rent and the number of HMOs have negative but insignificant impacts. Entry of the second firm (α_2) negatively[19] affects profits but neither the third (α_3) nor the fourth (α_4) does so significantly.

Per capita equilibrium quantity is affected negatively by wages, rent, the number of HMOs, and proportion commuting – all as expected. Per capita income has a positive and significant effect. The proportion of the population aged 65 or older has a positive but insignificant impact. Quantity rises with distance to the nearest small city, also as expected.

[17]Because of the "summing up" constraints appearing immediately below equation 17, p_5 and μ_5 do not appear.

[18]Setting the parameter on market population ($\lambda_{marketpop}$) equal to 1 is a necessary normalization.

[19]Recall that the sum of the squared α's enters negatively in the variable profits equation.

Distance to a big city has a negative and significant impact on quantity, which is unexpected. This may be due to unobserved heterogeneity – markets that are farther from big cities may have hospitals that are smaller or have fewer service offerings. Entry of the second and fourth[20] firms (δ_2, δ_4) have a significant positive effect on quantity, while the entry of the third firm (δ_3) does not.

Few of the fixed cost parameters are significant at conventional levels; although, with the exception of rent, they have the expected signs. Fixed costs rise with the second and third firms in the market, but not with the fourth.

Finally, the parameters of the discrete factor approximation are highly jointly significant, and the distribution of η exhibits a substantial positive skew. η is clearly non-normal, demonstrating the benefit of using the discrete factor approximation. The negative value of β shows a negative correlation between the unobserved components of V_N and d_N. As indicated earlier, this reflects heterogeneity in the toughness of competition among markets.

4.2 Ratios

Table 4 contains the estimated population thresholds for a hypothetical market with all covariates at their mean values. We report threshold ratios for this hypothetical market in Table 5. Only the first ratio is significantly different from one at conventional levels. Point estimates show rapid convergence to "competitive" levels of conduct. Taking the results at face value with the Bresnahan and Reiss (1991) interpretation (i.e., taking fixed costs as unchanging in the number of firms), we see that entry by a second firm substantially increases the toughness of competition. The third firm's entry increases the toughness of competition little if at all, and the fourth firm's even less. It then appears that the effects of entry on competition are exhausted at two or perhaps three firms.

[20] It is worth noting that the category here is four or more firms; therefore, the estimate of the quantity effect for the fourth firm captures not just the effect of the fourth firm's entry but also some of the effect of successive firms' entry. Also, this catch-all category is quite different from the other categories. Some of these small cities are likely drawing referrals from well beyond our fifteen mile ring for fringe population, likely inflating the effect of entry in this category.

The ratios in Table 5 cannot distinguish between a change in fixed costs versus a toughening of competition, so we move to Table 6, which contains a decomposition of the changes in the threshold ratios due to changes in variable profits, per-capita quantity, and fixed costs, along the lines of equation 9. These results show (at point estimates) that average variable profits fall with the entry of the second but not the third or fourth firms. Similarly, per capita quantity rises with the second but not the third firm's entry. However, per capita quantity rises again in the "fourth and more" category. This result is difficult to interpret, as discussed previously (footnote 20). Finally, fixed costs appear to rise for each successive entrant. Overall, the results paint a clear picture of competition getting tougher with entry — variable profits fall and quantity rises. Further, the (qualitative) inference regarding welfare seems clear. Competition results in increased consumption, whether due to lower prices or higher quality, so consumers must be better off.[21]

5 Summary and Conclusions

The relationship between market structure and competition is central to industrial organization. In this paper we augment the empirical approach developed by Bresnahan and Reiss for industries where there are good data available on quantity in addition to market structure.

We use this approach to examine the relationship between market structure and competition in hospital markets. Since the U.S. health care system is primarily market-based, effective competition in these markets is critical. Antitrust authorities have opposed hospital mergers where they have felt they would be anticompetitive. The courts in recent years have rejected these attempts to block hospital mergers.

We find evidence that entry leads to a significant increase in competition in the hospital markets we examine. Interestingly enough, most of the impact on competition comes from

[21] Due to the presence of moral hazard due to health insurance, it is commonly contended that lower prices in health care markets are welfare decreasing, since they will only exacerbate the excess consumption from moral hazard. Gaynor et al. (2000) show that this is not true if insurance markets are competitive.

the entry of a second hospital into a one hospital market. Subsequent entry has a much smaller estimated effect on competition. The policy prescription is that the antitrust enforcement agencies should be particularly concerned about merger for monopoly in isolated, rural hospital markets like the ones we analyze. This is relevant, since quite a few recent hospital mergers have had this character.[22] Mergers that reduce the number of hospitals from three to two or from four to three have, on average, lesser impacts on competition.[23]

[22]For example, cases in Poplar Bluff, Missouri (FTC et al vs. Tenet Healthcare Corporation, et al, FTC File No. 971-0090), Ukiah, California (Adventist Health System/West (1994, 117 FTC 23)), Roanoke, Virginia (U.S. v. Carilion Health System (707 F. Supp. 840)). See Gaynor and Vogt (2000) for more details.

[23]Our results indicate that on average for the markets we study here, entry of a fourth and perhaps a third firm has little impact on competition. Of course this is subject to the caveat that antitrust impacts are specific to the particulars of a market. Thus a merger reducing the number of firms from three to two could be anticompetitive for any particular market.

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Table 1: Market Structure and Population

Hospitals in Market	Number of Markets	Average Population
0	205	9,562
1	346	19,004
2	49	51,930
3	8	70,379
4+	5	114,087

Table 2: Variable Definitions and Descriptive Statistics

Variable Name	Definition	Mean	Std Dev
Quantity	Adjusted admissions, market (1000s)	5.50	7.82
Market population	City population (100,000s)	0.20	0.20
Fringe population	Non-city population within 15 miles (100,000s)	0.16	0.13
Commuters	Proportion commuting 45+ min to work	0.06	0.03
Proportion 65+	Proportion of city population age 65+	0.17	0.05
# HMOs	# HMOs in county	0.96	1.56
Per-capita income	City per-capita income ($1000s)	10.77	2.21
CON	Dummy for state certificate of need law	0.56	
Wage index	CMS wage index (base=1)	0.80	0.08
Rent	City median gross rent ($1000s)	0.31	0.07
Construction cost	Adjusted CMS construction cost index (base=1)	0.88	0.10
Distance→big	Distance to place with pop. > 100K (100s miles)	1.02	0.15
Distance→small	Distance to place with pop. > 5K (100s miles)	0.29	0.15
Military base	Dummy for military base > 500 employees	0.04	

Table 3: Maximum Likelihood Parameter Estimates

Parameter	Estimate	Std Error	t-Stat
Market Size (S)			
Market population	1.000	N/A	N/A
Fringe population	0.683	0.071	9.65
Military base	0.017	0.018	0.93
Variable Profits (V)			
α_1	1.147	0.376	3.05
Wage index	0.122	0.452	0.27
Rent	-0.558	0.482	-1.16
Per-capita income	-0.027	0.009	-2.96
# HMOs	-0.010	0.010	-0.97
Proportion 65+	1.059	0.431	2.45
Commuters	0.038	0.534	0.07
Distance→big	0.028	0.040	0.69
Distance→small	0.195	0.138	1.41
α_2	0.708	0.121	5.86
α_3	0.000	0.440	0.00
α_4	0.204	0.206	0.99

Table 3: Maximum Likelihood Parameter Estimates

Parameter	Estimate	Std Error	t-Stat
Per Capita Quantity (d)			
δ_1	29.317	3.892	7.53
Wage index	-16.464	4.480	-3.67
Rent	-16.980	6.309	-2.69
Per-capita income	0.883	0.153	5.78
# HMOs	-0.672	0.161	-4.17
Proportion 65+	5.348	7.773	0.69
Commuters	-55.107	7.869	-7.00
Distance→big	-1.863	0.651	-2.86
Distance→small	11.640	2.259	5.15
δ_2	2.249	0.137	16.40
δ_3	0.000	0.366	0.00
δ_4	2.202	0.153	14.43
Fixed Costs (F)			
γ_1	2.946	1.618	1.82
Wage index	1.287	2.326	0.55
Rent	-2.974	2.067	-1.44
Construction cost	0.153	0.912	0.17
CON	0.203	0.144	1.41
γ_2	0.687	0.415	1.66
γ_3	0.806	0.139	5.82
γ_4	0.374	0.936	0.40

Table 3: Maximum Likelihood Parameter Estimates

Parameter	Estimate	Std Error	t-Stat
Error Distributions			
p_1	0.044	0.012	3.56
p_2	0.223	0.086	2.60
p_3	0.097	0.027	3.54
p_4	0.509	0.090	5.66
μ_1	16.280	0.977	16.66
μ_2	-3.244	0.819	-3.96
μ_3	8.584	0.906	9.47
μ_4	0.518	0.668	0.78
σ_ν	1.698	0.100	16.96
β	-0.005	0.002	-2.45
Number of Observations		613	
Log-Likelihood		-1310.03	

Table 4: Per-Firm Population Thresholds

# Hospitals	Threshold	Std Error
1	16,947	753
2	29,767	1,720
3	34,913	7,242
4+	32,497	7,872

Table 5: Threshold Ratios

Ratio	Estimate	Std Error	Competition	Cournot
s_2/s_1	1.76	0.096	1.00	2.25
s_3/s_2	1.17	0.257	1.00	1.78
s_4/s_3	0.93	0.094	1.00	1.56

Table 6: Threshold Ratios' Decomposition

Component		2/1	3/2	4+/3
Fixed Cost	F_{N+1}/F_N	1.14	1.17	1.03
Variable Profit	V_{N+1}/V_N	0.51	1.00	0.92
Per-Capita Q	d_{N+1}/d_N	1.27	1.00	1.20
Overall	s_{N+1}/s_N	1.76	1.17	0.93

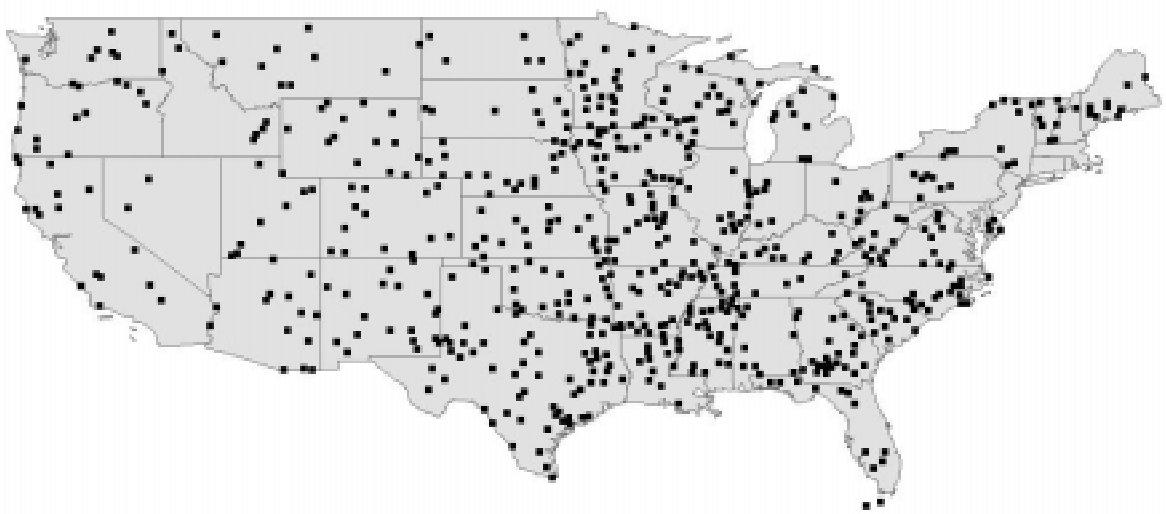

Figure 1: Geographical Distribution of Hospital Markets