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DIFFERENTIATION AND COMPETITION IN HMO MARKETS*

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This paper examines how differentiation among Health Maintenance Organizations (HMOs) affects local market competition. Most markets for HMOs appear sufficiently unconcentrated; however, differences among HMOs may make competition less intense than the number of competitors would suggest. To investigate this possibility, we distinguish HMOs that serve only local markets from those that operate regional or national networks. We analyze how HMOs of one type affect the profitability of the other using an equilibrium model of entry and product choice. While the two types of HMOs have strong competitive effects within segments, the competitive effect of differentiated firms is negligible.

I. INTRODUCTION

In this paper we examine the effect of differentiation among Health Maintenance Organizations (HMOs) on local competition. When analyzing HMO competition, researchers and antitrust enforcers alike have recognized that HMOs compete for customers within distinct local geographic markets. In general, they have considered all HMOs within a local market as equivalent competitors.[1] However, HMO differentiation may blunt competition across HMO types, and thus such market analyses may misstate the competitiveness of local markets. In this paper we identify and investigate the effects of one such difference, geographic scope, and demonstrate that local markets are strongly segmented between those HMOs with narrow geographic scope, that only serve a local market, and HMOs with broad scope, that provide services in many markets throughout the country.

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[1]For example, studies of price competition among HMOs, such as Wholey, Feldman and Christianson [1995], treat HMOs as homogeneous products.

Until recently, it was widely regarded that most local markets had several HMOs offering homogeneous products. As a result, policy makers gave little thought to the competitiveness of HMO markets, and HMO mergers were largely immune from antitrust scrutiny. This view changed when the Department of Justice required Prudential and Aetna to divest some holdings in a few local markets as a precondition for merger approval; it signaled that all HMO markets were no longer assumed to be competitive. This merger also called attention to the growth of a handful of 'national HMOs,' which appear to differentiate themselves from local HMOs by offering one stop shopping for national employers. The combination of consolidation and differentiation among HMOs necessitates a closer look at how HMOs compete.

A common yardstick for assessing the competitiveness of a market is to compute a concentration index such as the Herfindahl. Another approach is to compute own and cross-price elasticities of demand.[2] Neither approach offers a definitive measure of competitiveness, particularly in markets with differentiated competitors. The theoretical basis for the use of the Herfindahl is a Cournot equilibrium with homogeneous firms, so it is not well suited for assessing the extent of competition among differentiated sellers. The cross-price elasticity of demand approach yields useful results for market structure simulations, but requires more detailed data than are commonly available and does not account for strategic interaction among firms in concentrated markets.

Recent research in empirical industrial organization offers new methods for evaluating the competitiveness of markets using counts of operating firms. In these methods, a discrete choice estimation model is derived by combining a reduced-form profit function with a game theoretic model of entry and competition. Based upon this relatively simple structure, the researcher makes inferences on margins and rivalry from information about market size and the number of competitors. This is particularly attractive in industries where the data required to perform a structural demand-and-supply analysis—detailed information on prices, quantities, and product characteristics (e.g., Nevo [2000])—are not available. Because HMOs typically customize their offerings for their important clients (large firms) and arrive at price and product characteristics through individual negotiations, an approach that relies only on observed entry behavior is useful for this industry.

The logic behind our approach is straightforward. As Bresnahan and Reiss [1991] (henceforth 'BR') note, the quantity needed for a firm to cover

[2] Wholey, Feldman and Christianson [1995] use their analysis of cross-price elasticities of demand to draw conclusions about HMO competition. Nevo's [2000] examination of the RTE cereal industry represents a recent application of structural demand-and-supply estimation to this problem.

its fixed costs of entry will be lower if that firm earns higher margins. Therefore, to the extent that the presence of additional competitors reduces margins, the average quantity needed to support each additional entrant increases. Empirically, if we observe the average size of the market per firm increasing with the number of firms, we can infer that margins are falling as the number of firms increases. The rate at which average quantity is increasing indicates how rapidly margins are falling. As the average quantity per firm levels off, margins are no longer falling.

The effects of competitors on margins are less clear in heterogeneous product markets. If there are distinct groups of customers that strongly prefer each product based on its particular characteristics, high margins can be maintained in the presence of multiple competitors. The empirical model developed by Mazzeo [2002] extends the BR methodology to the case of firms offering discrete product types. The data represent the outcomes of firm decisions regarding (a) whether to enter the market, and (b) which product type to produce, given the choices of their competitors. Estimates from this model measure the incremental effect of additional competitors on operating profits, explicitly distinguishing between the effects of firms with similar and different product characteristics.

We use the BR and Mazzeo approaches to examine the nature of competition in HMO markets. We initially proceed as if HMOs are homogeneous products. In this BR-style analysis, we find that the market size required to support a second firm is roughly the same as the average size of monopoly markets. After two firms, the average market size required for additional firms increases, suggesting that margins fall when markets have more competitors. One potential explanation for this result is product differentiation—HMOs that pursue broad geographic coverage may not directly compete with HMOs that operate exclusively within a particular local market. This differentiation effect will be particularly evident in duopoly markets where there may be one HMO of each type.

We evaluate this hypothesis using a Mazzeo-style analysis. Our results support the differentiation explanation: the estimates indicate that competition within product types is quite strong, but that HMOs of the other product type provide little additional competition. Considering the two distinct product types reveals that HMO markets are less competitive than they would otherwise appear. In addition, we are able to isolate demographic characteristics across markets that predict the presence of either local or national HMOs. These results provide insight into the source of the competitive advantage afforded to each type of HMO firm.

The remainder of the paper is organized as follows. Section II describes the HMO industry, highlighting distinct HMO strategies. We outline our data in section III. In section IV we present the alternative estimation methodologies and show how to incorporate product differentiation into

the empirical model. Section V presents our estimation results and section VI concludes.

II. DIFFERENTIATION AMONG HMOS

To understand differentiation among HMOs, it is important to recognize that HMOs typically sell to employers. Thus, we consider differentiation among HMOs that reflects differences in preferences among employers. There may be several dimensions along which employer preferences for HMOs may differ. For example, some employers may prefer HMOs that excel in preventive care, whereas others prefer HMOs that offer access to the best physicians in their local market. Almost all HMOs can offer similar coverage and have the opportunity to contract with virtually the same set of providers, so meaningful differentiation along these dimensions is likely to be minimal.

We focus on differentiation based on the geographic scope of the HMO's business.[3] Just as some firms maintain a single, local establishment whereas others have establishments throughout the nation, some HMOs do business in only one market, whereas others do business nationwide. For reasons we discuss below, employers whose operations cover broader geographic regions may prefer to contract with HMOs that also cover a broad geographic area.[4]

If geographic coverage turns out to be an important source of differentiation, this could profoundly affect measures of competition. This is because there are only a handful of HMOs that provide service beyond a single, local market. To identify them, we computed the share of U.S. population that is represented in the counties where each HMO does business, as listed in Interstudy. In 1997, there were over 150 HMOs in the United States; the HMOs with the 25 highest levels of geographic coverage are listed in Table I. Six HMOs did business in enough markets to be

[3]HMOs represent a subset of the total market for health and health insurance services. Alternatives include Preferred Provider Organizations (PPOs), network-based managed care plans that allow more flexibility to patients at a higher cost, and indemnity plans, which pay a portion of covered charges from any provider. Competition authorities have long considered HMOs a distinct unit for analysis (Bloch, Wu and Perlman, [1999]); individual employees may choose between these alternatives since employers often offer options in each type of plan (at different costs). Cross-sectional differences in the take-up of the various alternatives are not available. Instead, we use demographic characteristics of each market to control for the attractiveness of the higher cost/quality alternatives and, therefore, the market size for HMOs. This will be discussed further in Section V.

[4] We had several conversations with HMO executives. They generally agreed that HMOs can be divided into 'national' and 'local' sellers that serve substantially different sets of consumers. HMOs appear to be exploiting this difference in their marketing—a radio advertisement for a national HMO includes a testimonial from the HR-manager of Ingersoll-Rand. She says that she prefers to contract with (this particular) national HMO because, 'we have employees all across the nation. It is important that they receive the same level of benefits.'

TABLE I
NATIONAL POPULATION COVERAGE OF LARGEST HMOS

HMO Firm	Population Coverage (%)
CIGNA HealthCare, Inc.	81.0
Humana, Inc.	60.5
Aetna U.S. Healthcare, Inc.	60.1
United Healthcare Corporation	58.6
Foundation Health Systems	53.6
Prudential Health Care Plans, Inc.	49.2
NYL Care Health Plans	25.9
Kaiser Foundation Health Plans, Inc.	25.6
Great West Life & Annuity Insurance Company	25.4
PacifiCare Health Systems, Inc.	25.4
Maxicare Health Plans, Inc.	21.8
Oxford Health Plans	17.1
Principal Health Care, Inc.	16.9
Mid-Atlantic Medical Services, Inc.	12.1
Health Insurance Plan of Greater New York	11.1
Anthem Health Plans	11.0
AmeriChoice Corporation	7.0
Mutual of Omaha Companies	6.8
WellCare Management Group, Inc.	6.5
Medical Mutual of Ohio	6.5
United American Healthcare Corporation	6.3
AMERIGROUP Corporation	5.7
Coventry Corporation	5.7
Watts Health Systems, Inc.	5.1
AmeriHealth, Inc.	5.0

available to at least half the nation's population. A second group of 10 are available to between 10 and 25 percent of potential U.S. customers. The remaining HMOs, which we call local HMOs, are available to no more than 7 percent of the population. Hence, there appears to be a clear demarcation between the few HMOs that have built large regional or national networks and the rest, which limit their operations to a particular local area. This pattern appears to be stable over time; prior to a wave of mergers in the late 1990s, HMOs were not significantly expanding or reducing their geographic coverage.

The drivers of geographic scope differentiation have not been widely studied in the literature on HMOs. Several hypotheses, based upon demand and cost drivers, might explain the differences. On the demand side, geographically disperse employers may prefer to contract with a single HMO that operates in all of their locations to provide employment-based health services rather than contracting with several, local providers. Using a single provider potentially lowers contracting costs, and may result in standardized contracts and care. On these criteria, smaller employers are indifferent between contracting with national or local HMOs; some may even prefer local HMOs that tailor their offerings to the needs of local populations.

Other explanations focus on cost differences. For example, one might conjecture that there are two cost curves for HMOs. Small, local HMOs may

have relatively low average costs because they have greater local market knowledge and have better relationships with hospitals. An HMO run by a local hospital system, for example, would have this sort of advantage, as would one run by local physicians and other members of the community. In addition, local HMOs might have lower monitoring costs. Finally, a local HMO may be able to custom-design a modest, low-cost benefits package to meet the needs of price-sensitive employers, whereas national HMOs may offer relatively standardized, generous packages that reflect the desires of their national clients.[5]

National HMOs may enjoy certain economies of scale and scope that reduce their costs. National HMOs can develop monitoring and screening programs to assure that contracting providers practice cost-effective medicine. National HMOs can develop drug evaluation programs and purchase prescription drugs in bulk to reduce pharmacy costs. It would be very difficult for a local HMO to obtain these sorts of cost advantages. The types of large-scale investments required to successfully operate a national HMO may serve as barriers to entry, limiting the number of participants in this segment of the market.

In addition to these demand and cost considerations, there are a number of regulations that might affect the profitability and ease of entry by local and national HMOs. Medicare allows seniors to enroll in HMOs, but the process of establishing a Medicare-eligible HMO is cumbersome and payment levels can fluctuate from year to year. Certain state Medicaid programs encourage or even mandate enrollment in HMOs. But Medicaid usually pays less than private employers for the same HMO services. States also have laws regarding capital and other financial requirements for new HMOs; these laws may be designed, in part, to assist local firms.

These different effects are not mutually exclusive and may well contribute to the potential for earning profits for both types of firms. Whatever the underlying reasons for the emergence of local and national HMOs, an important question for market analysis is to what extent an additional national (local) HMO affects competition among other national (local) HMOs, and among local (national) HMOs. The answer to this question provides insight into the degree of segmentation in the market, and to what extent one should consider each segment separately when analyzing the effect of a change in market structure due to merger, acquisition, or entry. It is this question that our empirical analysis addresses.

[5] The 2000 Kaiser Family Foundation Employee Health Benefits Survey reports that the benefits packages of HMOs offered by large employers are more generous than those offered by small employers. Large employers were more likely to provide coverage of all nine services listed in the survey, including adult physicals and mental health care.

Our focus on geographic scope contrasts with the existing literature on HMO differentiation that has looked at organizational differences that affect costs and flexibility of services. Prior research has investigated the difference between staff and group model HMOs on the one hand, and network and IPA models on the other, finding for example that the former generally achieve greater reductions in utilization than the latter.[6] Ownership status (for-profit versus nonprofit) and cost containment strategy (e.g., use of stringent financial controls) have also been studied, finding for example that financial incentives are an effective way to change physician behavior, but third party utilization review has only a small effect.[7] While these differences may also represent meaningful sources of differentiation, we focus on geographic scope differentiation here because of its importance in the eyes of employers, employees and regulators. Our methods are not rich enough to simultaneously consider differentiation along all of these dimensions at the same time.

III. DATA

Our HMO data come from the Interstudy database for the year 1997. Interstudy uses data maintained by state regulatory agencies to create a complete census of HMOs operating throughout the United States, including the states and counties in which each HMO offers its services.[8] An HMO is defined as operating in a specific county if it has contracts with providers in that county. Since we do not have county-level enrollment data, we assume that HMOs are actively competing in all counties in which they have contracts with providers in place. Based on this assumption, we constructed a list of the HMOs operating in a series of local markets, and identify their type (national or local) based on the set of markets they serve.

The empirical work below proceeds by analyzing market structure in a cross-section of independent geographic markets. Because it is critical to control for demographic conditions, market areas must be defined in such a way that (1) consumers do not typically use firms from outside the geographic area and (2) all the firms in the geographic are able to compete with each other. Previous work using similar methods has accomplished (1)

[6] The first category of HMOs typically has tightly restricted access to physicians who are either employed by the HMO or belong to a physician group that is closely aligned with the HMO. The second category of HMOs generally contract with independent physicians or groups of physicians; in turn, the physicians may contract with many different HMOs.

[7] Glied [2000] provides a nice summary of the empirical literature on managed care.

[8] As such, the firms identified by Interstudy are the ones that meet state regulatory requirements for HMOs. The Interstudy dataset also contains limited information on enrollment, age, affiliation, tax status, federal qualification, services offered, HMO penetration, and the percent of uninsured patients. These data are not sufficient to perform a structural demand-and-supply (e.g., Nevo [2000]) analysis of competition among HMOs.

and (2) by analyzing isolated geographic markets with a limited number of firms (BR, [1991]; Mazzeo, [2002]). Given the nature of HMO services, the market definitions are somewhat broader in this case.

We first recognize that employers typically purchase HMO services on behalf of employees, and that employees strongly prefer to use medical services from local providers.[9] Since only those HMOs that have contracted with local providers are in a position to compete for the business of individual employers, the Census-defined Metropolitan Statistical Area (MSA) unit is a natural basis for our market definitions. An MSA typically consists of a reasonably large central city and the neighboring counties from which a substantial portion of the residents commute into the central city for work. Thus, an employer might expect to have employees living throughout the MSA that would look for an HMO that had contracts with providers located near their homes. However, employees would be unlikely to travel outside the MSA for services they can obtain from inside the MSA. We also include markets not quite large enough to qualify as MSAs but that nonetheless may contain sufficient demand to support HMOs.[10]

Larger urban areas that potentially have distinct submarkets are inappropriate for this analysis, as they often encompass regions that extend well beyond what many employees might be expected to travel. As such, all the HMOs in these areas may not be relevant competitors with each other. Therefore we omit from our sample the Census's Consolidated Metropolitan Statistical Areas (CMSAs), which combine a series of contiguous MSAs into a single market definition.[11] Similar difficulties may exist in the larger markets that are not CMSAs; therefore, we exclude markets with population greater than 500,000. This also ensures additional homogeneity among the markets we analyze, and guarantees that our focus remains on competitive interactions among oligopolists. These choices gave us a total of 263 markets to be used for this study.

Table II displays a summary of our data by the number of HMOs operating in a market. While 5 markets do not have any HMOs operating and 10 only have a single HMO, 58 markets have 8 or more HMOs. In Table III, we split the HMOs into two mutually exclusive categories—local and national. We define local HMOs to be those available to less than 7 percent

[9] For evidence of local preferences, see, for example, Capps et al. [2003].

[10] Any U.S. county with at least 30,000 in total population was designated as a market, so long as it contains a single city with population of at least 15,000 and it does not border an MSA. We experimented with several alternative market definitions that included even smaller counties; this did not substantially alter the empirical results.

[11] For example, the Chicago CMSA covers a stretch of territory from Kenosha County in southeast Wisconsin to Porter County in northwest Indiana. While it is conceivable that firms in Chicago might have employees living in both areas, there are likely many employers at the extremes of the CMSA who would only require locally provided health services. In addition, we omit MSAs from New England, whose borders do not correspond to county boundaries (recall that the Interstudy data list the counties in which each HMO operates).

TABLE II
TOTAL NUMBER OF HMOS PER MARKET

Number of Operating HMOs	Number of markets	Frequency (%)
0	5	1.9
1	10	3.8
2	31	11.8
3	42	16.0
4	37	14.1
5	28	10.6
6	33	12.5
7	19	7.2
8	20	7.6
9	12	4.6
10	13	4.9
11	5	1.9
12	4	1.5
13	2	0.8
14	1	0.4
15	1	0.4
Total	263	100.0

TABLE III
NUMBER OF HMOS PER MARKET BY TYPE

	Local HMOs					
National HMOs	0	1	2	3	4	5+
0	5	7	1	8	1	1
1	3	24	16	7	6	4
2	6	17	15	3	6	5
3	1	9	13	5	4	6
4	5	5	9	7	4	4
5+	4	9	6	14	12	11

of the population. The national category contains the larger HMOs listed in Table I, as well as the Blue Cross affiliated HMOs.[12]

Table III indicates a very striking pattern of product differentiation. For example, in the 31 markets with two HMOs operating, 24 consist of one local and one national firm. These raw data strongly suggest some underlying pattern of entry in which differentiation is optimal—if local and national firms were equally likely to enter the market under all circumstances, we would expect as many as 24 of the 31 markets to have one firm of each type less than 0.05 percent of the time. Among the 42 markets with three HMOs,

[12] The Blue Cross designation is granted to a single HMO in each state—a multistate HMO may or may not be the Blue Cross affiliate in each state where it operates. The affiliation, therefore, provides some of the benefits of a national HMO network, even if the HMO only operates locally. We have classified the Blue Cross HMOs as national; however, the empirical results in the following section remain intact if the single-state Blue Cross affiliates are classified as local HMOs.

33 contain at least one local and one national firm. Again, this would be highly unlikely if the entry of local and national HMOs were independent and equally likely. Instead, it appears that differentiation in the geographic scope of HMOs may affect their entry decisions. If a market already has one local HMO, it is more likely that the next HMO will be national, and vice versa. The analyses in the following section incorporate this notion of differentiation into the assessment of the competitiveness of markets for HMO services.

Competitive factors alone do not determine the pattern of entry. Market characteristics also potentially affect the profitability of each type of HMO. Local population is the most natural proxy for market size. We obtained the local population estimates for 1997 from the U.S. Census Publication, *USA Counties—1998*, as well as the percent of the population over 65 years of age. Differences in these variables across markets should be correlated with differences in the overall demand for health care. We also want to control for the relative attractiveness of HMOs (as compared to other types of health insurance) in each market. For employees, we used income as a proxy since alternatives to HMOs provide more flexible service at additional costs. Large employers may prefer to contract with HMOs based on their scale; we include the fraction of business establishments with greater than 100 employees. We will examine the extent to which these variables predict the total number of HMOs in each market and whether they are associated with either type (local or national) of HMO.

TABLE IV
VARIABLE DEFINITIONS

Variable Name	Description	Mean	Std. Dev.
Ln(Population)	Natural logarithm of MSA population Source: U.S. Census, 'USA Counties—1998'	11.81	0.73
Per Capita Income	Total income/population Source: U. S. Census, 'USA Counties—1998'	18,752	2,708
Older Resident Share	Fraction of population, 65 years old or older Source: U. S. Census, 'USA Counties—1998'	0.13	0.04
Extra Hospital	Residual from equation predicting number of market hospitals Source: Authors' calculations	0.35	1.30
Big Establishment Share	Fraction of all MSA establishments with 100 or more employees Source: County Business Patterns, 1997	0.006	0.002
State Regulation	Point-of-Service (0/1) + Taxation (0/1) Source: State by State Guide to Managed Care Law	0.84	0.74

Two other market characteristics might also affect HMO costs. As shown by Dranove et al. [1998], HMOs can reduce their costs relative to other forms of health insurance if they are able to bargain effectively with providers. To capture this effect, we measure the number of hospitals in each market relative to the number one would expect for its size. (This allows us to disentangle hospital effects from sheer market size effects). Finally, each state regulates HMOs in a variety of ways. Using data from the *State by State Guide to Managed Care Law*, we measure two regulations that might drive up entry costs. One regulation requires that the HMO offer a 'point of service' plan, which effectively requires the HMO to deal with all providers in the state, not just those with which it has contracts. The other subjects HMOs to state taxation. For our analysis, we create a composite variable that is the sum of two 0/1 dummies reflecting the presence or absence of these laws. This composite might reflect an overall propensity to regulate HMOs.

IV. MARKET STRUCTURE AND PROFITABILITY

The empirical analyses in this paper are designed to examine the competitive consequences of concentrated industry structure in the HMO industry. The frameworks used are among a series of 'multiple-agent qualitative-response' models introduced into the industrial organization literature to evaluate entry strategies and market competition.[13] In these models, firms' strategies can be represented by discrete decisions (e.g., enter/don't enter a particular market) that are determined by evaluating the profitability of potential alternatives. The goal of the econometrician is to estimate parameters of the profit functions by using data on the firms' observed decisions. Estimation of the profit functions is complicated by the fact that the decisions of competing firms may affect the profitability of the potential alternatives—for example, entry may be less profitable if other firms have also entered the market. A game theoretic behavioral model is therefore used to infer individual firm profitability from an observed market structure outcome, determined by the choices made by interacting agents. We begin by analyzing the relationship between HMO counts and market size using the BR methodology. This method does not address the potential for firm heterogeneity to relax competition among HMOs; to capture these effects we analyze a model where HMOs of different types decide whether to enter the market.

Following BR, we posit a simple yet flexible profit function—in a symmetric equilibrium in market m, the profit of each firm is given by:

$$(1) \qquad \Pi_m = (\text{Variable Profits})_m * (\text{Market Size})_m - (\text{Entry Costs})_m.$$

[13] In addition to the papers cited here, see Berry [1992], Toivanen and Waterson [1999] and Seim [2000]. Reiss [1996] provides a discussion of the empirical framework.

The effects of competition are incorporated by allowing variable profits to be a function of the number of firms.[14] Specifically, let the profits of each of n symmetric firms operating in market m equal:

$$\Pi_{n,m} = X_m\beta - \mu_n + \varepsilon_m \tag{2}$$

where X_m are exogenous market factors (including market size), μ_n measures the effect of n competitors on per-firm profits, and ε_m is a market-level error term assumed to follow a normal distribution. We assume that firms enter the market if they earn nonnegative profits. Therefore, the probability of observing n firms in equilibrium equals:

$$P(\Pi_n \geqslant 0 \text{ and } \Pi_{n+1} < 0) = \Phi(\overline{\Pi}_n) - \Phi(\overline{\Pi}_{n+1}) \tag{3}$$

where Φ is the cumulative normal density function and $\overline{\Pi}_n = X_m\beta - \mu_n$. We can use an ordered probit model to estimate this relationship.

To accommodate differentiation among competitors, we employ a model that endogenizes product type choice as well as entry. We permit competitors to be one of two types (e.g., 'local' or 'national') and posit a separate profit function for competitors of each type. This allows us to determine whether same-type competitors affect profits more than different-type competitors. We include both the number and product types of competitors as arguments in the reduced-form profit function. We treat all firms within a given profit type as symmetric.

Given these assumptions, we can specify the profits of a firm of type T in market m, where market m contains N_1 firms of type 1 and N_2 firms of type 2:[15]

$$\pi_{T,m,N_1,N_2} = X_m\beta_T + g(\theta_T; \vec{N}_1, \vec{N}_2) + \varepsilon_{Tm}. \tag{4}$$

The first term represents market demand characteristics that affect firm profits (note that the effect of X_m varies by type). The $g(\theta_T; \vec{N}_1, \vec{N}_2)$ portion of the profit function captures the effects of competitors, with the vectors $\vec{N}_1$ and $\vec{N}_2$ representing the number of competing firms of each type. Parameters in the $g(\theta_T; \vec{N}_1, \vec{N}_2)$ function distinguish between the effects of same-type

[14] This formulation implicitly assumes that the market size does not enter into the tastes of consumers. As such, an increase in observed per-firm quantities can be correlated with a reduction in margins. It is also possible that incumbent firms could erect more explicit barriers-to-entry, causing entry costs to rise as the number of market participants increases. We will not be able to distinguish between these two explanations in this analysis.

[15] This specification of the profit function was chosen primarily to make the estimation tractable. Following Berry [1992] and Bresnahan and Reiss [1991], it can be interpreted as the log of a demand (market size) term multiplied by a variable profits term that depends on the number (and product types, in this case) of market competitors. There are no firm-specific factors in the profit function. The error term represents unobserved payoffs from operating as a particular type in a given market. It is assumed to be additively separable, independent of the observables (including the number of market competitors), and identical for each firm of the same type in a given market.

and different-type firms on profits, and capture the incremental effects of additional firms of each type. The parameter vector θ also varies across types, T, so that the competitive effects may differ by type. The unobserved part of profits, $\varepsilon_{\mathrm{Tm}}$, is assumed to be different for each product type in a given market.

To proceed, we need to make an assumption about the nature of the entry process. We will start by assuming that there are two possible types of HMOs that could enter a given market—national (S) or local (L). Abstracting from differences among firms of the same type, firms that do enter market m earn $\pi_{Tm}(\vec{N}_1, \vec{N}_2)$, where T is the product type of the firm and $\vec{N}_1$, $\vec{N}_2$ represents the number and product types of all the competitors that also operate in market m.[16] Firms that do not enter earn zero. Players sequentially make irrevocable decisions about entry before the next firm plays. Firms anticipate that subsequent firms will have the opportunity to make decisions about entry and product type once they have committed to their choice. For this game, a Nash Equilibrium can be represented by an ordered pair (S, L) for which the following inequalities are satisfied:

$$(5)\qquad \begin{array}{lll} \pi_S(S-1,L)>0 & \pi_S(S,L)<0 & \pi_S(S-1,L)>\pi_L(S-1,L) \\ \pi_L(S,L-1)>0 & \pi_L(S,L)<0 & \pi_L(S,L-1)>\pi_S(S,L+1) \end{array}$$

As long as we assume that an additional market participant always decreases profits and that the decrease is larger if the market participant is of the same product type, a unique equilibrium exists.[17]

Under our assumptions above, the inequalities corresponding to exactly one of the possible ordered-pair market structure outcomes are satisfied for every possible realization of (ε_S, ε_L) based on the data for the market in question and values for the profit function parameters. Assuming a distribution for the error term, a predicted probability for each of the possible outcomes is calculated by integrating $f(\varepsilon_S, \varepsilon_L)$ over the region of the $\{\varepsilon_S, \varepsilon_L\}$ space corresponding to that outcome.[18]

[16] We assume that firms optimize on a market-by-market basis, which may be somewhat more realistic for local HMOs than for national HMOs (it is conceivable that a national HMO might enter an individual market to broaden its coverage, even if that market is not individually profitable). By not analyzing the larger markets that would be more attractive for this purpose, difficulties caused by this difference should be mitigated.

[17] Mazzeo [2002] contains proofs of existence and uniqueness. Note that $\vec{N}$represents the product types of competing firms (not including itself). For a national firm in market (S, L), $\vec{N} = (S-1, L)$; for a local firm, $= \vec{N}(S, L-1)$.

[18] In the estimation, markets are constrained to have no more than five firms of either product type. The region corresponding to a product-type configuration with zero or five national or local firms operating, therefore, is unbounded on at least one side. The appropriate integration limit is (plus or minus) infinity.

Since the equilibrium is unique, the sum of the probabilities for all market configurations always equals one. Maximum likelihood selects the profit function parameters that maximize the probability of the observed market configurations across the dataset. The likelihood function is:

$$L = \prod_{m=1}^{M} \text{Prob}\left[(S,L)_m^O\right] \tag{6}$$

where $(S,L)_m^O$ is the observed configuration of firms in market m—its probability is a function of the solution concept, the parameters and the data for market m. For example, if $(S,L)^O = (1,1)$ for market m, the contribution to the likelihood function for market m is Prob$[(1,1)]$.

V. ESTIMATION RESULTS

Our first empirical analysis predicts the total number of HMOs that operate in each market, without making distinctions between local and national firms. To do so, we estimate an ordered probit model. As described above, the coefficients indicate how each parameter—e.g., income—affects the profitability of HMOs. The estimated parameters also allow us to calculate entry-threshold ratios, which provide evidence on how additional market concentration affects firm profitability.

Table V presents the ordered probit results with seven entry categories—markets with six or more HMOs are placed in the same category. Several market level variables are important for explaining the number of HMOs in a market. The coefficient on the log of population, our primary measure of quantity in subsequent analysis, is positive and estimated quite precisely. As per capita income increases, the number of HMOs declines, all

TABLE V
ORDERED PROBIT RESULTS; DEPENDENT VARIABLE = NUMBER OF HMOS IN THE MARKET

Parameter:		Estimate	Standard Error	z
Ln (Population)	β_P	0.94	0.11	8.62
Per Capita Income	β_I	− 8.18E-5	2.79E-5	− 2.94
Older Resident Share	β_O	6.58	2.23	2.96
Extra Hospital	β_{EH}	0.96	0.06	1.58
Big Establishment Share	β_{BE}	77.10	28.31	2.72
State Regulations	β_R	− 0.29	0.10	− 2.86
Cut1	μ_1	8.15	1.34	
Cut2	μ_2	8.74	1.34	
Cut3	μ_3	9.55	1.35	
Cut4	μ_4	10.20	1.36	
Cut5	μ_5	10.67	1.38	
Cut6	μ_6	11.01	1.38	

Notes: Number of observations = 263, LR $\chi^2(6) = 103.59$, Pseudo $R^2 = 0.12$, Log likelihood = − 375.22. See Table IV for variable definitions and data sources.

else equal, indicating that HMOs are an inferior good. Since demand for health care is likely to be positively correlated with income overall, we interpret the income parameter to represent the strength of higher quality alternatives to HMOs, such as PPOs and indemnity plans. We also find that the number of HMOs is increasing in the share of older residents and the share of large employers in the market. These may reflect demand side influences—the relatively lower cost of HMOs may be more attractive to these groups. The effect of large establishments on the number of HMOs could also reflect cost side explanations if administration costs are lower when the HMO is contracting with fewer employers for the same number of enrollees. Looking further at the cost side, we find that areas with more hospitals than predicted have more HMOs, while fewer HMOs operate in markets where they are more heavily regulated.[19]

The ordered probit estimation generates a set of 'cut points,' which correspond to the constants that separate adjacent response categories μ_n. These estimates can be used to examine the relationship between market size and the number of operating firms. As noted previously, if we expect that variable profits are higher in more concentrated markets, then the average quantity per firm should increase as the number of firms increases. Using population as a natural measure of quantity (enrollees), we rewrite the profit function underlying the ordered probit estimation to isolate the market size contribution:

$$\Pi_{n,m} = \beta_P * \ln(population) + X_m\beta - \mu_n + \varepsilon_m \tag{7}$$

which means that n firms are observed if:

$$\mu_n < \beta_P * \ln(population) + X_m\beta < \mu_{n+1} \tag{8}$$

Holding the other market characteristics constant at their mean levels, we can solve for the minimum population required to support n HMOs:

$$Population = \exp\left\{\frac{\mu_n - \overline{X}\beta}{\beta_P}\right\}. \tag{9}$$

From these, we calculate the predicted minimum average population per firm in a market with n firms, s_n, referred to as the *threshold quantity*. We also compute the threshold ratio s_{n+1}/s_n. If margins fall as the number of firms increases, we expect the threshold ratio to exceed 1, indicating that the

[19] We implicitly assume that these regulations are exogenous to a market's structure; to the extent that firms in a concentrated market might be able to encourage the imposition of regulations to protect their market power, the estimated parameters may be attenuated. In the case of HMO taxation, 14 of the 29 states that imposed taxes instituted them prior to 1978—well prior to the establishment of many of the firms in this study.

minimum average quantity needed to cover fixed costs is increasing with the number of firms.[20]

Table VI displays the predicted threshold ratios and minimum market quantity based on the estimates of Table V. The non-monotonic relationship between the entry threshold ratios and the number of firms is striking. The threshold ratio for two firms is close to one, increases to 1.58 for three firms, and continues to fall thereafter. Recall that a threshold ratio of one indicates that the presence of an additional firm does not result in lower per-firm margins than existed in a market with one fewer firm. Therefore, our estimates imply that the margins earned by HMO duopolists are roughly the same as those earned by monopolists. This result is consistent with several possibilities—the second firm might collude with the first, there could be substantial competition from other forms of insurance (so that HMO monopolists only earn the competitive level of profits), or the duopolists might be highly differentiated.[21] The fact that the threshold ratio for the third firm rises to 1.58 strongly suggests that the monopolists and duopolists earn rents. An important implication is that other forms of insurance—e.g., PPOs—do not generate sufficient competitive effects to eliminate HMO margins on their own. The next analysis explores whether product differentiation can explain this pattern.

To evaluate the effect of product differentiation on competition, we now apply the second empirical framework described in the previous section. We allow for up to five firms of each product type in the market—therefore, the dependent variable can take on one of 36 possible values. The profit function to be estimated contains the function $g(\theta_T; \vec{N}_1, \vec{N}_2)$ that captures the effects of competitors and their product types. For each firm type and market configuration, a set of dummy variables is defined, and the corresponding θ-parameters represent the incremental effects of additional competitors.

[20] When computing thresholds, we implicitly assume that the relative demand for PPOs is uncorrelated with population size. Otherwise, the effective size of the HMO market would not increase in proportion to the population, and we would misstate the intensity of HMO competition. There are several reasons why we discount this possibility. First, the threat that employers could self-insure probably limits the pricing of even 'monopoly' PPOs, suggesting that PPO prices are not likely to be highly correlated with market size. Second, papers like Wholey Feldman, and Christianson [1995] and Abraham, Vogt and Gaynor [2002] compute cross-price elasticities among HMOs that are much greater than between HMOs and PPOs. Given the historically narrow profit margins in managed care, it is unlikely that competition among PPOs could lead to large enough reductions so as to materially affect the demand for HMOs. To confirm our intuition, we examined the ratio of PPO to HMO penetration for 50 MSAs of varying sizes. (Data provided by PULSE for 1994.) The correlation between this ratio and population was small, negative and not statistically significant ($p = .33$).

[21] In the homogeneous products industries studied by BR, the estimated threshold ratios were monotonically decreasing and reached one with four or five market participants. They interpreted this result to indicate that such markets were 'competitive,' since margins did not decrease further with lower market concentration.

TABLE VI
ESTIMATED ENTRY THRESHOLD RATIOS CALCULATED USING ORDERED PROBIT ESTIMATES

Number of Firms	Threshold ratios	Estimated Population
1	—	8,689
2	0.93	16,181
3	1.58	38,289
4	1.50	76,365
5	1.30	124,409
6	1.20	178,658

The reported estimates reflect the following specification of the competitive-effect dummy variables:[22]

$$
\begin{aligned}
g_{\text{LOCAL}} &= \theta_{\text{LL1}} * \text{presence of first local competitor} \\
&\quad + \theta_{\text{LL2}} * \text{presence of second local competitor} \\
&\quad + \theta_{\text{LL3/4}} * \text{number of additional local competitors} \\
&\quad + \theta_{\text{LS}} * \text{number of national competitors} \\
g_{\text{NATIONAL}} &= \theta_{\text{SS1}} * \text{presence of first national competitor} \\
&\quad + \theta_{\text{SS2}} * \text{presence of second national competitor} \\
&\quad + \theta_{\text{SS3/4}} * \text{number of additional national competitors} \\
&\quad + \theta_{\text{LS}} * \text{number of local competitors}
\end{aligned} \tag{10}
$$

As in the ordered probit, the appropriate X-variables to include are either correlated with HMO demand or costs in each market.[23] The profit function specification also allows the effects associated with the X-variables to vary by product type. The results are presented in Table VII.

The estimated parameters indicate the relative profits earned by local and national HMOs depending on market conditions and the competitors they face. For example, the relative value of the constants indicates that if we hold market characteristics constant, a monopoly national HMO is slightly more

[22] The goal is to make the specification of the competitive effects through $g(\theta_T; \vec{N})$ as flexible as possible, while maintaining estimation feasibility. For example, in the cases where the data indicate the 'number' of competitors, we implicitly assume that the incremental effect of each additional competitor is the same.

[23] The estimation routine performs better if the ranges of the explanatory variables' data are close to each other. Therefore, the X-variables that are always positive are transformed as follows:

$$X_m^* = \ln\left[X / \frac{1}{263}\sum_{m=1}^{263} X_m\right]$$

Consequently, a value for X equal to the mean in the dataset is transformed to zero; a value above the mean becomes positive and a value below the mean becomes negative. The variables that can take on a value of zero or below (state regulations and extra hospitals) are not transformed.

TABLE VII
PROFIT FUNCTION ESTIMATES FROM EQUILIBRIUM PRODUCT CHOICE MODEL

Parameter		Estimate	Standard Error
Effect on Profits for Local HMOs			
Constant	C_L	1.79	0.13
Local Competitor #1	θ_{LL1}	−1.07	0.10
Local Competitor #2	θ_{LL2}	−0.68	0.07
Local Competitor #3 & #4	$\theta_{LL3/4}$	−0.57	0.05
# of National Competitors	θ_{LS}	−8.8e-8	2.7e-5
Population	$\beta_{L\text{-}P}$	0.56	0.08
Per Capita Income	$\beta_{L\text{-}I}$	0.03	0.43
Older Resident Share	$\beta_{L\text{-}O}$	−0.13	0.22
Large Establishment Share	$\beta_{L\text{-}BE}$	0.66	0.12
State Regulations	$\beta_{L\text{-}R}$	−0.14	0.08
Extra Hospitals	$\beta_{L\text{-}EH}$	0.12	0.04
Effect on Profits for National HMOs			
Constant	C_S	2.04	0.14
National Competitor #1	θ_{SS1}	−1.05	0.11
National Competitor #2	θ_{SS2}	−0.61	0.06
National Competitor #3 & #4	$\theta_{SS3/4}$	−0.46	0.04
# of Local Competitors	θ_{SL}	−1.1e-7	3.3e-5
Population	$\beta_{S\text{-}P}$	0.81	0.09
Per Capita Income	$\beta_{S\text{-}I}$	−1.62	0.44
Older Resident Share	$\beta_{S\text{-}O}$	1.14	0.24
Large Establishment Share	$\beta_{S\text{-}BE}$	−0.05	0.12
State Regulations	$\beta_{S\text{-}R}$	−0.22	0.08
Extra Hospitals	$\beta_{S\text{-}EH}$	0.02	0.05

profitable than a monopoly local HMO ($C_S = 2.04$ vs. $C_L = 1.79$).[24] Factoring in market conditions, however, can change this relationship. For example, suppose that in market m, the population is one-sixth the sample mean, and the other X-variables are multiplied by data equal to zero.[25] With no competitors, profits earned by a local HMO are on average higher ($\pi_L = 1.79 + (-1.79) * (0.56) = 0.79$) than for a national HMO ($\pi_S = 2.04 + (-1.79) * (0.81) = 0.59$). This result is not surprising, given the raw data. For example, in the one-HMO markets, the mean population in cases where the firm is local is lower than the mean population where it is a national firm. In fact, five of the six least populated one-HMO markets have a (0, 1) rather than a (1, 0) configuration.

The estimated competitive effects on HMO type, as captured by the θ-parameters, are striking. The estimates indicate that the effects of competitors on profitability come almost exclusively from same-type HMOs. For both local and national firms, the presence of a same-type

[24] The comparisons in this section are of predicted profits, assuming that the unobservable part of profits for both types is zero. Converting these comparisons into formal tests would require assumptions about the higher moments of the profit function errors.

[25] That is, there are no state regulations, exactly the number of hospitals predicted for the market, and the remaining variables are at the sample mean. To simulate a market with population at one-sixth the sample mean, the parameter estimate for population is multiplied by $\ln(1/6) = (-1.79)$, to compute the predicted payoffs. Seventeen markets have population below one-sixth the sample mean.

competitor cuts baseline profits by more than half ($\theta_{LL1} = -1.07$; $\theta_{SS1} = -1.05$), while the presence of competitors of the other product type have a negligible impact on profits. This provides strong evidence that HMOs are differentiated by geographic scope, and that this differentiation is a profitable strategy. To illustrate, consider a market with average values for the X-variables when a national HMO already operates. Profits for a local firm would be $\pi_L = 1.79 + (-0.00) = 1.79$, while profits for a second national firm would be $\pi_S = 2.04 + (-1.05) = 0.99$. The relative difference between the competitive effect of same and different-type firms explains why the presence of a second HMO did not appear to increase competition in the entry threshold analysis. The raw data in Table III also reflect the economic significance of these results. It would take an unusual combination of market conditions to offset the incentive to differentiate; it is not surprising that, for example, the number of (1, 1) markets greatly exceeds the number of (0, 2) and (2, 0) markets.[26] We conclude that product differentiation insulates HMOs from lower margins that typically result from reduced competition in homogeneous product markets.

The remaining θ-parameters represent the incremental effects of additional competing firms. These effects become smaller as the market concentration decreases. For example, the effect of the second national competitor on profits for national HMOs is about two-thirds the effect of the first national competitor ($\theta_{SS1} = -1.05$ vs. $\theta_{SS2} = -0.61$); the third and fourth national competitors' effects are smaller still ($\theta_{SS3/4} = -0.46$). This result suggests that, within the individual HMO product types, margins fall with each additional competitor, but at a decreasing rate with larger numbers of firms. This is exactly the pattern found in the homogeneous product industries studied by Bresnahan and Reiss. In table VIII, we present entry threshold ratios calculated separately for the local and the national HMOs.[27] While their values are somewhat higher (since a market with two

[26] Continuing with the example above, if population and older residents share are each twice the sample mean, a national HMO in a (2, 0) configuration would be more profitable than a local HMO in a (1, 1) configuration. Each of these conditions occurs separately in the dataset, but in no markets are they both true.

[27] As before, we solve for the minimum average quantity required to support N firms of type i ($i = S, L$) by setting the profit for that type equal to zero. Thus for a firm of type T with one own competitor we solve:

$$\Pi_{T2} = \beta_{TP} * \ln(\text{population}/\text{population mean}) + X_m\beta + C_T + \theta_{T1} = 0.$$

Assuming the mean level of the market characteristics, we can solve for the minimum population required to support two same type HMOs as:

$$\textit{Population} = \exp\left\{\frac{-C_T - \theta_{T1}}{\beta_{Tp}}\right\} * \text{population mean}$$

We do not include the small cross-type effects on profits; however, they would theoretically play a minor role—since the second local HMO would very likely have at least one national competitor, while a single local firm may or may not.

TABLE VIII
THRESHOLD RATIOS FOR LOCAL AND NATIONAL HMOS

Number of Firms	Threshold ratios	Estimated Population
	Local HMOs	
1	—	8,137
2	3.38	54,992
3	2.25	185,206
4	2.08	512,514
	National HMOs	
1	—	17,445
2	1.83	63,773
3	1.42	135,424
4	1.32	238,964

local HMOs invariably has three and may well have as many as five total competitors, and vice versa), the entry threshold ratios do monotonically decline as we expect. This provides additional evidence that the surprising result in Table VI was due to competition-reducing product differentiation.

The remaining *X*-variables estimates from Table VII indicate that our market characteristics have different effects on the profitability of local and national HMOs across markets. As shown above, population has a positive and significant effect on profits of both product types, but the relative size of the coefficients indicates that firms in markets with population above the sample mean tend to favor national HMOs, while local HMOs are more profitable in below-average population markets. More interesting are the market characteristics that predicted the presence of additional HMOs in the ordered probits, but appear to have different effects on firm profitability depending on the HMO type. For example, the per capita income variable has a negative effect on the profitability of national HMOs only. This suggests that local HMOs represent a higher level of quality than national HMOs, and that individuals with higher incomes would avoid national HMOs in favor of the higher quality/cost health insurance offerings (like PPOs and indemnity plans). Since many of the local HMOs in our dataset are affiliated with universities and regional hospitals, it is not surprising that they would have solid reputations with local consumers and employers.

The within-type profit function coefficients also demonstrate that markets with a greater share of older residents are more attractive for national HMOs, but not for local HMOs. We interpret this result to be a consequence of national firms providing HMO services to Medicare patients within the markets in which they operate.[28] HMOs that operate nationally may be

[28] Indeed, several national HMOs, including CIGNA and Foundation Health, do a disproportionate amount of business in the Medicare HMO market.

better equipped than their local counterparts to meet the federal standards and requirements necessary to serve Medicare patients. In addition, since Medicare recipients are not directed to HMOs through employers, the national firms may have an advantage in developing marketing techniques to attract individual seniors.

The large establishment employment share coefficients were somewhat surprising; initially we had expected these large establishments to also be ones that had a national presence. The profit function estimate, however, indicated that the local HMOs gain more from having more large establishments within their markets. It appears that many of our smaller markets contain a few large one-establishment firms, while the dispersed establishments of national firms have fewer employees. Without more details on the larger corporate affiliation of establishments across geographic markets, we cannot pin this effect down more precisely.[29]

The two remaining variables indicate how costs might vary for national and local HMOs. The presence of additional state regulations negatively affects the profitability of national HMOs, but had little effect on local firms. This is consistent with regulation protecting local firms. The local HMOs do appear to benefit from additional competition among hospitals, as the positive coefficient for β_{L-EH} suggests. While national HMOs may be more easily able to exploit scale economies to achieve costs savings, local HMOs need favorable market conditions—such as lower market concentration among key suppliers—to thrive.

Taken together, the results of the differentiated product analyses highlight two important features regarding the profitability of operating HMOs. The θ-parameters starkly demonstrate the role that product differentiation plays in limiting competition among HMOs—the negative effect on profits is much greater when competitors cover the same breadth of geographic scope. Local HMOs have little competitive effect on national HMOs and vice versa. In addition, the β-parameters suggest economic explanations for why particular markets would be more attractive places for local and national HMOs to operate, respectively.

VI. CONCLUSIONS

Recent developments in econometric methodology have allowed economists and policy makers to make reasonable assessments of the competitiveness of markets—even without detailed data on demand, prices or costs. Empirical results from homogenous product industries suggest that competition increases rapidly as market concentration falls. The presence of one or two additional firms results in margins substantially lower than a similarly

[29] The data requirements to develop such a measure would be quite substantial. See, for example, Holmes [2001], which analyses branch offices for sales of large manufacturing firms.

situated monopolist would earn. Such results can provide guidance, for example, on how closely to scrutinize a merger that will reduce the number of competitors in an industry.

In heterogeneous product industries, however, firms offering similar services may not be direct competitors due to differences in their geographic location, customer base, or other aspects of their business strategy. This appears to be the case in HMO markets. Local HMOs do not have a substantial competitive effect on HMOs with a national geographic scope, and vice versa. The Federal Trade Commission is currently intensifying its scrutiny of HMO mergers. Our results suggest that FTC policy should account for such differentiation.

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