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THE EFFECT OF INCREASED SUPPLY ON EQUILIBRIUM PRICE: A THEORY FOR THE STRANGE CASE OF PHYSICIANS' SERVICES

by

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August, 1977

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I. Introduction.

In the United States between 1965 and 1974 physician fees rose at a slightly higher rate than the consumer price index. During the same period the number of practicing physicians per 100,000 population grew from 131 to 153.[1] Moreover in regions of the country that have a high physician-population ratio fees appear to be higher than in regions that have a low physician-population ratio. In 1970, for example, the New England region had 161 active physicians per 100,000 population and an average price of $9.40 for a routine follow-up visit by a specialist in internal medicine. The comparable average price was $7.20 in the East-South Central region even though the region only had 95 active physicians per 100,000 population.[2] These facts are counter to the intuition of the economist. The standard supply-demand, competitive model predicts that an increased

relative supply of physicians should cause lower prices, not the higher prices that this data and several econometric studies indicate.[3]

What might be going on? In particular, can a theory be constructed that, first, assumes physicians and consumers are maximizers and, second, is consistent with a positive relation between supply and price? My goal here is to answer this question affirmatively by constructing such a theory for the case of primary care physicians. This theory is of interest both as a specific contribution to our understanding of the market for physicians' services and as a general contribution to our knowledge of how supply may affect the equilibrium price within monopolistically competitive industries. Towards these ends, construction of this theory involves two logically distinct steps. First is to formulate a general model that describes the market for physicians services. Second is to argue that the model's parameters could plausibly assume values that imply a direct relation--rather than the conventional inverse relation--between prices and the supply of physicians. Whether the parameters actually do have values that lead to this direct relation is an empirical question whose answer lies beyond this paper's scope.

Within this paper I model the market for primary care physicians' services as a monopolistically competitive industry. This is appropriate because (i) physicians sell a highly differentiated product and thus are price setters and (ii) most markets contain enough physicians to prevent oligopolistic interactions. If within a monopolistically competitive market the demand that each firm faces becomes less elastic for some reason, then the equilibrium price they charge rises. The focus of this analysis is to show explicitly how an increase in the number of primary care physicians practicing within a community may cause the demand that each physician faces to become less elastic and, thus, cause the equilibrium market price to rise.

An outline of this analysis is as follows. The first step is to construct a simple Markov model of consumers' decisions to visit and switch among competing physicians. It shows that a principle determinant of the demand that any particular physician i faces is the probability that a consumer who has become dissatisfied with his current physician j will pick i as the replacement. This probability is called the physician i's acquisition rate. Specifically, the model shows that if the acquisition rate becomes less price elastic, then the physician's demand also becomes less price elastic. The second step is construction of a second Markov model that describes the amount of useful information a consumer typically possesses about the physicians in his community. It shows that as the number of physicians in the community increases, the information each consumer possesses tends to decrease. The third step is to use standard search theory to show that a decrease in consumer information may cause the acquisition rate to become less price elastic. Recalling the results of the first two steps, this implies that an increase in the number of physicians may cause each physician's demand to become less elastic. This completes the analysis because if demand becomes less elastic for each monopolistic competitor, then the equilibrium price they charge in the market increases.

This model of physician pricing is different than the models other authors have proposed. Their theories fall into three classes: competitive industry theories, monopolist theories, and target income theories. The first class includes work by Feldstein [6] and Fuchs and Kramer [9]. These models specify that physicians are price takers, an assumption that the obvious price setting power of individual physicians contradicts. The

work of Sloan [25], Steinwald and Sloan [27], Frech and Ginsburgh [8], and Masson and Wu [14] are examples of monopolist theories. These theories assume that the physician is a price setting monopolist who maximizes profits (or utility). Each of these papers provides insights into how a physician may react to particular changes in his external environment. For example, Frech and Ginsburgh present a clear exposition of how different types of insurance are likely to affect the physician's pricing decision. These models, however, can not determine how an increased supply of physicians affects price because they do not include a theory of how increased supply affects the demand each individual physician faces.[4]

The final class of theory is the target income model, a theory based on satisficing behavior rather than maximizing behavior. It is particularly important within the context of this paper because Newhouse [18] originally proposed it as an explanation for his empirical observation that price is positively related to physician supply.[5] Evans [3, 4] and Evans, Parrish, and Sully [5] have been its strongest advocates. It assumes that physicians have an income target and set their prices at a level that allows them to achieve this target. If excess demand exists at the resulting price level, then they use nonprice means to ration the quantity of services delivered. Since physicians in communities that have high physician-population ratios have low patient loads in comparison to physicians in communities with low physician-population ratios, they must, in order to achieve their target incomes, set their prices higher than do physicians in communities with low physician-population ratios. The defect of this explanation, as its supporters have noted, is that it is unable to explain how physicians determine their target incomes. More pointedly, why have physicians limited the increases in their income to the rate that has been observed?

The theory developed in this paper is necessarily a simplification of reality that focuses on some issues and excludes others. For example, the possible ability of physicians to create their own demand is not included in the analysis. This issue and three others that are excluded are discussed briefly in the concluding section. These limitations of the analysis, however, do not alter the paper's conclusion that maximizing behavior on the part of physicians and consumers is logically consistent with a positive relation between physician supply and the price of their services.

2. The Demand for Physician's Services

As stated in the introduction, the focus of this theory is an explicit analysis of how an increase in the number of primary physicians within a community may cause each primary physician's demand curve to become less elastic.[6] This section develops a model of how consumers switch among the competing physicians within the community. Its conclusion is that a physician's price elasticity of demand can be written as the sum of several, more basic price elasticities. This is useful because the effect of an increase in the number of physicians can then be analyzed by considering the effect that an increase in the number of physicians has on each of the terms that compose the physician's demand elasticity. The model developed here is similar to the brand choice models Telser [28] has developed in economics and Massy, Montgomery, and Morrison [15] have discussed in marketing.

Before embarking on formal development of the demand model, a brief overview of the theory's overall structure is appropriate. Every individual consumer has a personal, primary care physician whom he consults when he

becomes ill enough so that the expense of a visit seems worthwhile. Consumers occasionally change personal physicians. This can happen for any number of reasons; two possibilities are perceived poor service and an increase in price. When an individual does decide to change physicians he generally asks friends and associates for recommendations and makes a choice from among the recommended physicians based on his perceptions of their qualities and prices. Physician quality as I use it here is a subjective characteristic that is personal to each consumer. One consumer may think that a particular physician i is of outstanding quality because he has an empathetic manner while another consumer may think that the same physician i is of poor quality because his training is forty years out ot date. It is this subjective nature of quality that gives each physician his monopoly power. The mechanism is that every physician i has patients who think that he is a terrific physician. Therefore if i raises his price, some of i's patients may decide to switch to another physician, but those who think i is really terrific will tend to stay with him.

In the formal models that this paper contains I make the assumption that all primary care physicians within the community are of the same average quality. Consistent with quality being a subjective characteristic, this does not mean that individual consumers are indifferent among the physicians in the community. It means that if any two physicians in the community were matched against each other and randomly selected consumers in the community were asked to pick the one they preferred, then the consumers would be expected to split half and half between the two physicians.

With this background the formal model is understandable. Consider a community that has a population of N consumers and M practicing physicians. Each consumer in the community is a patient of one and only one physician. Let N_i^t represent the number of consumers who are members of physician i's consumer panel during week t.[7] Clearly $\Sigma_{i=1}^{M} N_i^t = N$. Let p_i be the price physician i charges, let $v_i(p_i)$ be the probability that a randomly chosen member of his panel visits him during week t, and assume that v_i is a decreasing function of p_i. Physician i's expected patient load for the next week is therefore $v_i(p_i)\ N_i^t$. The price p_i is the only argument of v_i for three reasons. First, the level of prices that other physicians charge is not likely to affect the probability that a person will visit his own physician. Second, as stated above, average quality is assumed to be equal across all physicians and therefore is not explicitly included as an argument of v_i. Third, v_i is a downward sloping function of p_i because the analysis concerns primary care physicians whose services are generally not covered by insurance.

Each consumer who is a member of physician i's patient panel periodically evaluates the satisfactoriness of the care he is receiving. Let the probability that during any given week he decides to switch to another physician be $s_i(p_i, \bar{p}_i)$ where $\bar{p}_i$ is the vector of other physicians' fees. Presumably s_i is an increasing function of p_i and a decreasing function of each component of $\bar{p}_i$, i.e. a consumer is more likely to switch to another physician if his present physician's relative price increases.[8] The expected number of consumers physician i expects to lose from his panel during week t is $\Delta\bar{N}_i^t = s_i(p_i, \bar{p}_i)\ N_i^t$. The probabilities v_i and s_i are respectively called physician i's visit rate and switching rate.

Each week physician i adds to his panel a number of consumers who are switching to him from other physicians with whom they have become dissatisfied. Let $w_{ij}(p_i, \bar{p}_i)$ be the probability that a patient who quits physician j picks physician i as his new physician. Necessarily

$$\sum_{\substack{j=1 \\ i\neq j}}^{M} w_{ij}(p_i, \bar{p}_i) = 1 \qquad (2.01)$$

because every patient who quits physician j must pick a new physician. The function w_{ij} is called physician i's acquisition rate with respect to physician j. It is assumed to be decreasing in p_i, i.e. the higher i's price, p_i, the smaller the probability that a dissatisfied consumer picks him. The expected number of new patients that physician i acquires during week t is he

$$\Delta^{+}N_i^t = \sum_{\substack{j=1 \\ j\neq i}}^{M} w_{ij}(p_i,\bar{p}_i)s_j(p_j,\bar{p}_j)N_j^t. \qquad (2.02)$$

Given the vector of prices $(p_1,\ldots,p_M)$ that physicians within the community are charging, the consumer panels of the M physicians are in equilibrium if each physician during the next week expects the number of new consumers gained to offset the number lost. If, for example, the number of new consumers $\Delta^{+}N_i^t$ that physician i expects to acquire in the next week exceeds the number $\Delta^{-}N_i^t$ that he expects to lose, then his patient panel is not in long run equilibrium because it will tend to grow.

Formally, for the given vector of prices $(p_1,\ldots, p_M)$ that the physicians are charging, the consumer panels are in long run equilibrium if the vector of panel sizes $(N_1,\ldots, N_M)$ satisfies the following M+1 equations:

$$N = \sum_{i=1}^{M} N_i \tag{2.03}$$

$$0 = -s_i(p_i, \bar{p}_i)\, N_i + \sum_{\substack{j=1 \\ j\neq i}}^{M} w_{ij}(p_i, \bar{p}_i)\, s_j(p_j, \bar{p}_j) N_j$$

$$i = 1, \ldots, M. \tag{2.04}$$

Notice that these equations are linear in the vector $(N_1, \ldots, N_M)$. Because each of the M equations of (2.04) is dependent on the other M - 1 equations of (2.04), one may be discarded. Therefore (2.03) and (2.04) constitute a system of M independent linear equations in M unknowns. Generally a unique solution exists for such a system.[9]

Consider a special, more tractable case of the above. Suppose initially that a symmetry among physicians exists in the specific sense that each charges the same price $p^o = p_1^o = \ldots = p_M^o$ and that a dissatisfied consumer who quits his present physician is equally likely to select each of the other M - 1 physicians. In other words, for all pairs of physicians (i,j)

$$w_{ij}(p_i^o, \bar{p}_i^o) = \frac{1}{M-1} \tag{2.05}$$

Now suppose the first physician raises his fees to $p_1 > p_1^o$ while the other M-1 physicians leave their fees unchanged. For the reasons discussed above the immediate effects of this increase is that physician one's visit rate $v_1(p_1)$ and acquisition rates $w_{1j}(p_1, \bar{p}_1)$, fall and his switiching rate $s_1(p_1, \bar{p}_1)$ rises. Since the other M-1 physicians are symmetric, setting all of physician one's acquisition rates equal to each other is appropriate:

$$w_{12}(p_1, \bar{p}_1^o) = w_{13}(p_1, \bar{p}_1^o) = \ldots = w_{1M}(p_1, \bar{p}_1^o) = \omega(p_1) \tag{2.06}$$

where the function ω is decreasing in p_1.

Constraint (2.01) implies that the decline in physician one's acquisition rates ω must be offset by increases in the other physicians' acquisition rates. Therefore, for all i=2, ..., M and all j=2, ..., M such that $i \neq j$, let

$$w_{ij}(p_1, \bar{p}_1^o) = \frac{1-\omega(p_1)}{M-2} \tag{2.07}$$

where $\bar{p}_1^o = (p_2^o, \ldots, p_M^o)$. Also let

$$w_{i1}(p_1, \bar{p}_1^o) = \frac{1}{M-1} \tag{2.08}$$

for all i=2, ..., M. The assumed symmetry among physicians justifies the specific functional forms of (2.07) and (2.08).

This specific structure allows equilibrium conditions (2.03) and (2.04) to be written as:

$$N = \sum_{j=1}^{M} N_j \; ; \tag{2.09}$$

$$0 = -s_i(p_1)\, N_i + \sum_{\substack{j=2 \\ i \neq j}}^{M} \frac{1-\omega(p_1)}{M-2}\, s_j(p_1)\, N_j + \frac{1}{M-1}\, s_1(p_1)\, N_1 \qquad i = 2, \ldots, M; \tag{2.10}$$

$$0 = -s_1(p_1)\, N_1 + \sum_{j=2}^{M} \omega(p_1)\, s_j(p_1)\, N_j. \tag{2.11}$$

Because the focus is on the effect of changing p_1, all function arguments with the exception of p_1 are suppressed. The system (2.09) through (2.11) may be written in matrix form:

$$\begin{bmatrix} N \\ 0 \\ 0 \\ \cdots \\ 0 \end{bmatrix} = \begin{bmatrix} \frac{1}{s_1(p_1)} & \frac{1}{s_2(p_1)} & \frac{1}{s_3(p_1)} & \cdots & \frac{1}{s_M(p_1)} \\ \frac{1}{M-1} & -1 & x & \cdots & x \\ \frac{1}{M-1} & x & -1 & \cdots & x \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \frac{1}{M-1} & x & x & \cdots & -1 \end{bmatrix} \begin{bmatrix} s_1(p_1)\ N_1 \\ s_2(p_1)\ N_2 \\ s_3(p_1)\ N_3 \\ \cdots \\ s_M(p_1)\ N_M \end{bmatrix} \tag{2.12}$$

where

$$x = \frac{1 - \omega(p_1)}{M-2} \quad . \tag{2.13}$$

Equation (2.11) has been excluded because it is dependent on equations (2.09) and (2.10).

The system (2.12) has an explicit solution:

$$N_1 = \frac{(M-1)\ N\ \omega(p_1)}{s_1(p_1)\left[\frac{(M-1)\omega(p_1)}{s_1(p_1)} + \sum_{j=2}^{M} \frac{1}{s_j(p_1)}\right]} \tag{2.14}$$

$$N_i = \frac{N}{s_i(p_1)\left[\frac{(M-1)\ \omega(p_1)}{s_1(p_1)} + \sum_{j=2}^{M} \frac{1}{s_j(p_1)}\right]} \tag{2.15}$$

for i=2, ..., M. Equations (2.14) and (2.15) are derived by doing a partitioned inversion of the square matrix in (2.12).

The number of patients that physician one expects to see during the next week is

$$Q_1(p_1) = v_1(p_1)\, N_1(p_1) \tag{2.16}$$

The function $Q_1(p_1)$ is physician one's long run demand curve: given that other physicians keep their fees constant, $Q_1(p_1)$ describes how his expected number of patient visits per week varies as he changes his price.[10] Therefore (2.14) and (2.16) allows computation of physician one's long run price elasticity of demand. It is

$$\begin{aligned} e^1_Q &= \frac{p_1}{Q_1(p_1)} \frac{dQ(p_1)}{dp_1} \\ &= e^1_v + C(p_1)\{e^1_\omega - e^1_s + \sum_{j=2}^{M} \alpha_j e^j_s\} \end{aligned} \tag{2.17}$$

where

$$e^1_v = \frac{p_1}{v_1(p_1)} \frac{dv_1(p_1)}{dp_1} < 0, \tag{2.18}$$

$$e^1_\omega = \frac{p_1}{\omega(p_1)} \frac{d\,\omega(p_1)}{dp_1} < 0, \tag{2.19}$$

$$e^1_s = \frac{p_1}{s_1(p_1)} \frac{ds_1(p_1)}{dp_1} > 0, \tag{2.20}$$

$$e^j_s = \frac{p_1}{s_j(p_1)} \frac{ds_j(p_1)}{dp_1} < 0, \tag{2.21}$$

$$\alpha_j = \frac{\dfrac{1}{s_j(p_1)}}{\sum_{k=2}^{M} \dfrac{1}{s_k(p_1)}} = \frac{1}{\sum_{k=2}^{M} \dfrac{s_j(p_1)}{s_k(p_1)}} \tag{2.22}$$

and

$$C(p_1) = \frac{\sum_{k=2}^{M} \dfrac{1}{s_k(p_1)}}{\dfrac{(M-1)\omega(p_1)}{s_1(p_1)} + \sum_{k=2}^{M} \dfrac{1}{s_k(p_1)}} \tag{2.23}$$

The quantities e_v^1, e_ω^1, and e_s^1 are respectively the price elasticities of physician one's visit rate, acquisition rate, and switching rate. The quantity e_s^j is the cross elasticity of physician j's switching rate with physician one's price. The coefficients $\{\alpha_2, \ldots, \alpha_m\}$ are a set of positive weights that sum to one. Thus, $\Sigma\alpha_j\, e_s^j$ is a weighted average of the cross elasticities of the M-1 physicians switching rates. Finally $C(p_1)$ has the property that $C(p_1^o) = M/M\text{-}1$. Therefore, when M is reasonably large and p_1 is not greatly different from p_1^o, an adequate approximation is

$$e_Q^1 = e_v^1 + e_\omega^1 - e_s^1 + \sum_{j=2}^{M} \alpha_j e_s^j \qquad (2.24)$$

Approximation (2.24) expresses physician one's demand elasticity as the sum of several more fundamental elasticities. Consequently the effect of an increase in the number of physicians may be analyzed in terms of the effect an increase has on each of the component elasticities.

3. A Description of Consumer Search for Personal Physicians

A general description of how consumers select their personal physician is necessary in order to construct a model for a term by term analysis of equation (2.24). In this section on the basis of casual empiricism and a skimpy literature I propose such a description.[11] In the succeeding two sections I transform this description into a specific model and demonstrate that an increase in the number of physicians may cause each physician's demand to become less price elastic.

The description is this. Consumers, by and large, search for a personal physician by asking their friends and relatives for recommendations and then making a choice based on convenience, sketchy information, and prejudice. Consumers do not generally consult with several possibilities, inquire about each one's qualifications and prices, and then make an informed choice. This lack of systematic search is not necessarily irrational; the costs of consulting several doctors are quite substantial in time and money and the benefits in terms of the information acquired are likely meager because of the difficulties that consumers have in evaluating physicians' skills.

The quality of information that a consumer receives from his friends and relatives depends on what they know. The crucial point that must be made is: as the number of physicians within a community increases, the usefulness of the information consumers possess concerning those physicians declines. The reason is that if the number of physicians is small--seven for example--then each physician has a detailed reputation throughout the community. Seven physicians are easy to keep track of. Each consumer has friends who go to each of the seven and each consumer can remember what is

said about each. If the number of physicians is larger--thirty, for example--then each physician's reputation is much less distinct. An average consumer can not accurately catalogue in his mind what he hears about thirty different physicians. Thus, the tendency in communities with a large number of physicians is for each consumer to have accurate information only about his own physician and, perhaps, one or two others. In a large city, where the number of physicians available to choose among is large, the usual response of a friend concerning the qualifications of a particular physician is, "I have never heard of him." Therefore, as M, the number of physicians within the community, increases, the quality of information consumers have concerning relative qualifications and prices of physicians declines.

No particular reason appears to exist why a decline in consumer information should affect the terms e_v^1, e_s^1, and $\Sigma\alpha_j e_s^j$ in equation (2.24). Hence I assume that an increase in M has no systematic effect on their values. On the other hand, an increase in M and consequent decline in consumer information does appear to affect e_ω^1, the elasticity of physician one's acquisition rate, in (2.24). The argument is this. As the information level within a community declines, each consumer's ability to find a physician who offers services that are low priced and, in the eyes of the particular consumer, are of high quality decreases. This means that each consumer's choice of a physician becomes more random and less sensitive to price. In other words, e_ω^1 increases towards zero and $\omega(p_1)$ becomes less elastic.

Equation (2.24) implies that if e_ω^1 increases towards zero and the values of e_v^1, e_s^1, and $\Sigma\alpha_j e_s^j$ remain approximately constant, then physician one's demand elasticity e_Q^1 also increases towards zero, i.e. his demand becomes less

elastic. Thus, the theory suggests that an increase in the physician-population ratio may cause a decline in consumer information and, consequently, a reduction in each physician's price elasticity of demand. This conclusion contrasts with the situation that is presumed to exist for most goods. In terms of equation (2.24) the usual case may be analysed as follows. Consider a good for which the consumer finds it economic to search directly for the best buy, e.g., groceries. Because entry of more firms into the grocery business reduces the average distance between competing grocers, entry tends to reduce consumers' costs of searching for a better buy. This, by a reversal of the arguments used in the physicians' services' case, causes e_{ω}^{1} to increase in absolute value as the number of grocers increases. Therefore an increase in the number of grocers should make demand for each grocer more price elastic. To use Nelson's [17] terminology the significant distinction between the markets for physicians' services and groceries is that the former is an experience good and the latter is a search good.

4. A Model of Consumer Search Cost

The previous section's argument is made explicit in this and the succeeding section. This section contains a model of search costs and concludes that as the number of physicians in a community increases the average level of consumer information in the community declines and causes the costs of searching for a new physician to rise. The next section contains a model of consumer search behavior. It shows that, under plausible assumptions, increased search costs imply for each physician a less price elastic acquisition rate and, therefore, a less price elastic demand curve.

Recall from above the postulated behavior of an individual who becomes dissatisfied with his present physician and decides to seek a new physician. He asks friends and associates for recommendations. The fruitfulness of a representative query depends on the number of physicians about which the friend provides useful information. Moreover, casual empiricism suggests that whenever an individual asks a friend for advice, he incurs a significant fixed cost in the form of good will expended and time spent exchanging pleasantries. Therefore, the average cost of learning the reputation of an additional doctor declines as each query, on average, nets usable information about more physicians.

A friend, when asked to recommend physicians, can at best only recount that information he possesses. Therefore, a model of how much information each consumer possesses concerning each physician is necessary. The rudimentary and preliminary model I propose is as follows.[12] Individuals in the normal course of social life talk with each other and occasionally exchange stories about their personal physicians.[13] Suppose that on average, each week, each individual picks a friend at random and exchanges doctor stories. Each individual listens and remembers what the friend says about the doctor. Over time,

however, the memory fades and eventually, unless it is reinforced by another friend, disappears. Thus, each individual has a set of constantly turning over memories about the different physicians in his community.

This process may be modeled as a Markov chain. Focus on individual consumer j and suppose, without loss of generality, that he is a patient of physician one. Let the (M-1) dimensional vector $\theta^t = (\theta_2^t, \theta_3^t, \ldots, \theta_M^t)$ represent his knowledge at time t about each of the other M-1 physicians. Let $\theta_i^t = 0$ represent no knowledge about physician i and let increasing values of θ_i^t represent increasing knowledge about physician i. Each period the value of θ^t changes in two ways. First, individual j forgets a little. This is represented by decrementing each component of θ^t by a positive constant δ subject to the constraint that a component can not be reduced below zero. Second, individual j picks a friend at random and the friend talks about his own physician. If consumers are uniformly distributed among physicians because all physicians charge approximately the same prices, then each physician each week has a 1/M probability of being discussed for the benefit of individual j. If physician i is the physician who is discussed, then θ_i^t is increased one unit. Thus,

$$\theta^{t+1} = \theta^t - \delta(\theta^t) + \mu \tag{4.01}$$

where

$$\delta(\theta^t) = [\delta(\theta_2^t), \delta(\theta_3^t), \ldots, \delta(\theta_4^t)], \tag{4.02}$$

$$\delta(\theta_j^t) = \begin{cases} \theta_j^t & \text{if } \theta_j^t - \delta \leq 0 \\ \delta & \text{if } \theta_j^t - \delta \geq 0 \end{cases} \tag{4.03}$$

and μ is a (M-1) dimensional random vector whose probability mass function is:

$$\Pr\{\mu = [0, 0, \ldots, 0]\} = \Pr\{\mu = [1, 0, 0, \ldots, 0]\}$$
$$= \Pr\{\mu = [0, 1, \ldots, 0]\} = \Pr\{\mu = [0, 0, \ldots, 0, 1, 0, \ldots, 0]\} \qquad (4.04)$$
$$= \Pr\{\mu = [0, 0, \ldots, 0, 1]\} = \frac{1}{M}.$$

The case where μ is the zero vector occurs whenever individual j talks to a friend who also goes to physician one. The case where μ is the unit vector with a one as the (i-1)th component occurs whenever individual j talks to a friend whose physician is i.

Now suppose a friend asks an individual j for information concerning physicians. First, j generally recounts his experience with his own personal physician. Additionally, he may share with his friend a portion of the hearsay that the information vector θ^t represents. He does this, however, only for those physicians about which he recalls enough to say something substantive. In other words, if individual j's information θ_i^t about physician i is less than some positive threshold level η, then he remains silent about that physician because he believes that that information θ_i^t is too incomplete or too unreliable to be of use to his friend. If, however, $\theta_i^t \geq \eta$, then he does not recount what he recalls concerning physician i.[14]

The expected number of physicians about which individual j gives useful information is therefore just one plus the expected number of components of θ^t that exceed the threshold η.[15] The question is: how does this expected value, which is a measure of the ease of searching for a new physician, vary as the number of physicians in the community varies?

Intuitive consideration of the model indicates that if the expected value of each component of θ^t is high and if the threshold value of η is low, then a query for information on average yields direct information about individual j's personal physician and secondhand information about several other physicians. Inspection of the model shows that as the number of physicians increases, the expected value of each component θ_i^t decreases. Therefore, the expected number of components of θ^t that exceed η decreases as the number of physicians increases. This means that the cost of searching for a new physician increases as the number of physicians in the community increases.

The correctness of this intuitive argument can, in principle, be checked by calculating the complete long run, steady state, distribution of θ^t and then computing for different numbers of physicians the expected number of components that exceed η. This is difficult, however, because when M, the number of physicians, is large, the state space for θ^t becomes very large. A more tractable approach is simulation. Table 1 reports simulation results for different values of M and δ. The results confirm the intuitive argument made above.[16] They therefore--to the degree that this model of consumer information is credible--lend support to the possibility that the costs of searching for a new physician increase as the number of physicians in a community increases.

Table 1. Effect of Number of Physicians on Consumer Information

$\delta = .125, \quad \eta = 1.25$

Number of Physicians Recommended

M	1	2	3	4	5	6	7	8	9	10	Average
10	0	0	0	3	10	15	16	5	1	0	6.26
15	0	3	25	13	8	1	0	0	0	0	3.58
25	7	24	15	3	1	0	0	0	0	0	2.34
35	30	16	4	0	0	0	0	0	0	0	1.48

$\delta = .167, \quad \eta = 1.25$

Number of Physicians Recommended

M	1	2	3	4	5	6	7	8	9	10	Average
10	0	6	17	20	6	1	0	0	0	0	3.58
15	12	24	13	1	0	0	0	0	0	0	2.06
25	25	23	2	0	0	0	0	0	0	0	1.54
35	35	14	1	0	0	0	0	0	0	0	1.32

$\delta = .125 \qquad \eta = .5$

Number of Physicians Recommended

M	1	2	3	4	5	6	7	8	9	10	Average
10	0	0	0	0	1	11	21	14	3	0	7.14
15	0	0	0	2	9	15	18	5	0	1	6.38
25	0	0	0	7	14	16	11	2	0	0	5.74
35	0	0	0	2	28	13	7	0	0	0	5.50

$\delta = .167 \qquad \eta = .5$

Number of Physicians Recommended

M	1	2	3	4	5	6	7	8	9	10	Average
10	0	0	0	12	24	12	2	0	0	0	5.08
15	0	0	4	20	21	4	1	0	0	0	4.56
25	0	1	8	17	20	4	0	0	0	0	4.36
35	0	1	4	30	13	2	0	0	0	0	4.22

Explanation: When the memory depreciation rate δ had value .125, the threshold η had value 1.25, and the number of physicians in the community was 15, then 8 of the 50 consumers simulated had information vectors Θ^t that enabled them to recommend 5 physicians. On average the 50 consumers were each able to recommend 3.58 physicians.

5. Consumer Search and the Price Elasticity of Demand

This section considers the individual consumer who has decided to seek a new physician. Given that he searches in the general manner described in Section 3, what is his optimal strategy, how does this optimal strategy change when his search costs increase, and what effect does this change in strategy have on the price elasticity of demand each physician faces? This section answers these questions and shows that under plausible assumptions an increase in search costs does make each physician's demand less price elastic. The path by which search costs are shown to affect each physician's demand elasticity is through equation (2.24) and the acquisition rate elasticity, e^i_ω.[17]

The model I use is as follows. Individual consumers who are seeking a new physician take price and quality as their criteria. Specifically, assume that individual i's evaluation of physician j is

$$u^i_j = \chi^i_j - \gamma p_j \qquad (5.01).$$

where χ^i_j is the quality of physician j as perceived by individual i, p_j is physician j's price, and γ is a positive parameter common to all consumers that describes the importance they place on price relative to quality. The crucial variable is the quality variable, χ^i_j. I continue to assume, as I did in Section 2, that every physician in the community is of essentially equivalent quality. Nevertheless, since no satisfactory measure of physician quality is available, a consumer's evaluation of a particular physician's quality is personal and subjective. Factors such as the physician's personality and office location may have as much impact on the value of χ^i_j as factors such as his training and experience. Consequently one consumer may rate physician j high, while another may rate him

low. Moreover each consumer's rating is assumed to be independent of every other consumer's rating. For example, if one individual rates physician j low, then no inference can be made that other individuals will on the average rate j low. Such inferences are inadmissible because they, if they were admissible, would violate the assumption that all physicians are of equivalent underlying quality.

Suppose, for the sake of specificity, that consumer i is seeking a new physician. He searches by asking his friends and associates for recommendations.[18] Assume that the informational content of any recommendation concerning physician j made by a friend is sufficient for i to form useable estimates of p_j, χ_j^i and, consequently, u_j^i. Let the average cost of search per recommendation obtained be d. Moreover, suppose that i believes that all physicians in the community charge a common price of p^o.[19] Individual i's search is therefore for quality, not price, though if he should find a physician who charges a price different than p^o, then he uses equation (5.01) to evaluate the importance of that difference. When individual i asks a friend for recommendations, he knows neither whom the friend will recommend nor how the recommended physician will rate on his, as opposed to the friend's, quality scale.

Let individual i be an expected utility maximizer and let the probability distribution $F(\chi)$ represent his uncertainty regarding the outcome of his inquiries of friends for recommendations. That is, if individual i seeks out a friend and asks for an additional recommendation, then i's subjective probability that the recommended physician's quality will be less than or equal to quality level χ_o is $F(\chi_o)$.[20] Individual i's problem is, therefore, a sequential

search problem. The standard theory for such problems states that his optimal strategy is to continue asking for recommendations until he finds a physician j such that

$$u_j^i \geq u^* \tag{5.02}$$

where u^* is called the reservation price-quality level.[21] Individual i picks u^* such that if he has not found a physician for whom $u_j^i \geq u^*$, then the gain in utility he expects to realize by seeking an additional recommendation and perhaps finding a physician of higher quality than he has already found either equals or exceeds the cost d of securing the addition recommendation. A well-known result is that as the cost of search d increases, the value of u^* decreases, i.e. as search becomes more expensive, individual i's minimum acceptable price-quality level u^* decreases.[22]

If all consumers are assumed to be identical in terms of their search costs d, their price quality trade-off γ, and their distributions $F(\chi)$, then calculation of the elasticity of each physician's acquisition rate is straightforward. Since all physicians are assumed to be identical, it is sufficient to calculate the elasticity of physician one's acquisition rate, e_ω^1. Recall that his acquisition rate, $\omega(p_1)$, is the probability that a consumer who is dissatisfied with some other physician will select him. Since consumers are assumed to make their quality judgments independently and to be identical in terms of their parameters γ, F, and d, any individual i can be used as a proxy for all consumers. Thus

$$\omega(p_1) = \Pr(A_1^i)\ \Pr\{B_1^i\ (p_1) \mid A_1^i\} \tag{5.03}$$

where A_1^i is the event that physician one is recommended to consumer i at some point during his search for a new physician and $B_1^i(p_1)$ is the event

that consumer i selects physician one. Notice that $\Pr(A_1^i)$, unlike $\Pr\{B_1^i(p_1) \mid A_1^i\}$, is not a function of p_1. This is because consumer i believes that all physicians charge the common price p^o; if physician one should charge a different price, then consumer i discovers the error in his expectations only after it is too late for him to change his search strategy and thus change $\Pr(A_1^i)$. The conditional probability that consumer i will select physician one is simply

$$\Pr\{B_1^i(p_1) \mid A_1^i\} = 1 - F\ (u^* + \gamma p_1) \tag{5.04}$$

where u^* is consumer i's reservation price-quality level. Equation (5.04) follows from the fact that if consumer i is to select physician one and if physician one changes price p_1, then individual i must perceive physician one's quality to be at least $u^* + \gamma p_1$. Otherwise $u_1^i = \chi_1^i - \gamma p_1 < u^*$ and consumer i rejects physician one.

The price elasticity of $\omega(p_1)$ may now be calculated from (5.03) and (5.04):

$$e_\omega^1 = \frac{p_1 \omega'(p_1)}{\omega(p_1)}$$

$$= - \frac{\gamma p_1\ F'\{u^* + \gamma p_1\}}{1 - F\{u^* + \gamma p_1\}} \quad . \tag{5.05}$$

where F', the first derivative of F, is the probability density function that F implies. The derivative of this elasticity with respect to u^* is:

$$\frac{\partial e_\omega^1}{\partial u^*} = - \gamma p_1 \frac{\{1-F(u^* + \gamma p_1)\} F''(u^* + \gamma p_1) + \{F'(u^* + \gamma p_1)\}^2}{\{1-F(u^* + \gamma p_1)\}^2} \tag{5.06}$$

The sign of $\partial e_\omega^1 / \partial u^*$ is indeterminate because F'', which is the slope of the probability density function F', may be either positive or negative depending

on the distribution that F represents and on the specific value of $u^* + \gamma p_1$. A special case occurs when F is exponential with parameter α:

$$F(\chi) = 1 - e^{-\alpha\chi} \tag{5.07}$$

For this case (and only this case) $\partial e_\omega^1/\partial u^* = 0$ for all values of α, p_1, and u^*. Classes of distributions exist such that $\partial e_\omega^1/\partial u^* > 0$. Still other classes of distributions exist such that $\partial e_\omega^1/\partial u^* < 0$.[23]

This means that the principle determining factor for the sign of $\partial e_\omega^1/\partial u^*$ is the distribution F that describes consumers' beliefs regarding the quality of physicians. Even though no empirical evidence exists on this question, certain deductions can be made. Specifically, the probability density function derived from a representative consumer's distribution function $F(\chi)$ certainly has a bounded right hand tail. Suppose that physician one sets his price p_1 much higher than the prevailing market price p^o. If consumer i's density function $F'(\chi)$ has an unbounded right hand tail, then no matter how high physician one sets his price, there is a positive probability that χ_1^i will be of sufficient magnitude to offset that high price and make physician one acceptable as his doctor. In other words, no matter how great p_1, $\Pr(\chi_1^i - \gamma p_1 \geq u^*) \neq 0$. This does not square with my intuition. If a physician charges too much above the prevailing market price, then I (a representative consumer) will not utilize him no matter how good his reputation is.[24] This argument, if accepted, rules out the normal distribution as well as the exponential distribution.[25] More generally, it rules out all distributions for which $\partial e_\omega^1/\partial u^* > 0$ everywhere.[26] It leaves distributions such as the uniform distribution and the various triangular distributions as plausible possibilities for $F(\chi)$. For these distributions $\partial e_\omega^1/\partial u^* < 0$ everywhere.

In other words, for plausible possibilities such as the uniform and triangular distributions, an increase in the reservation price-quality level causes each physician's acquisition rate to become more price elastic. The simple model of information transmission and depreciation presented in Section 4 demonstrated that an increase in the number of physicians within a community may cause consumer search costs to increase. Standard search theory shows that an increase in search costs cause consumers' reservation price-quality level, u^*, to fall. Therefore, this section's conclusion that $\partial e^1_\omega / \partial u^* < 0$ implies that an increase in the number of physicians may cause each physician's acquisition rate to become less elastic. Equation (2.24) then implies that a less elastic acquisition rate results in a less elastic demand curve. Therefore, an increase in the number of physicians in the community may cause each physician's demand to become less elastic.

6. Pricing Setting and Market Equilibrium

Physicians have multiple goals in their practice of medicine, one of which is to earn a living. Therefore periodically each physician reviews his price structure with the goal of increasing his net income. This is the rationale for the assumption on which I base this section's model: a physician's objective when he revises his price structure is to maximize his net income.[27]

Focus on physician i and consider a static model of his costs and demand. Assume that the service he delivers is homogeneous and divisible. Let p_i be the price he charges and let $\bar{p}_i = (p_1, \ldots p_{i-1}, p_{i+1}, \ldots, p_m)$ be the vector of prices the other M-1 physicians charge. Let $Q(p_i, \bar{p}_i)$ be the quantity that he delivers if he charges price p_i and other physicians charge prices $\bar{p}_i$. Assume that all physicians have constant marginal costs of c per unit of service and fixed costs of C per period. Physician i's net income for the next period is therefore

$$\pi_i(p_i, \bar{p}_i) = (p_i - c)\, Q(p_i, \bar{p}_i) - C \qquad (6.01)$$

His decision problem is to pick p_i to maximize $\pi_i(p_i, \bar{p}_i)$.

Physician i in picking p_i is assumed to take $\bar{p}_i$ as given, i.e. he is assumed to behave in a Cournot manner. The basis for this assumption is that in any community with a large number of physicians a rise in price by one physician has a negligible effect on other physicians. Inspection of equation (2.15) that describes the size of physician j's consumer panel as a function of physician one's price shows explicitly the smallness of this effect. Consequently no physician has any reason to react specifically to another physician's price changes.

These assumptions imply that the market for physicians' services is in equilibrium if each physician i is charging the price p_i that maximizes his net income $\pi_i(p_i, \bar{p}_i)$ given the prices $\bar{p}_i$ of every other physician.[28] The goal of this section is to show that the equilibrium price for physicians' services within a community may increase if the number of physicians within the community increases. Proof of this comparative statics result is straightforward because of the assumptions made above that all M physicians are of identical underlying quality and have identical marginal costs.

The rule each physician uses to pick his price p_i is to set marginal cost equal to marginal revenue:

$$c = p_i \left(1 + \frac{1}{e_Q^i}\right) \qquad (6.02)$$

where the left side is marginal cost, the right hand side is marginal revenue, and e_Q^i is physician i's price elasticity of demand. His elasticity e_Q^i is a function of the prices $(p_i, \bar{p}_i)$ being charged in the market. As is always the case for firms with market power, a necessary condition for an optimal price to exist is that $e_Q^i(p_i, \bar{p}_i)$ be less than negative one for some price p_i.

Since all physicians are assumed to be identical, a perfectly symmetric market equilibrium where each physician charges an identical price $p = p_1 = p_2 = \ldots = p_M$ is likely to exist. Demonstration that under general conditions such an equilibrium does exist is as follows. Physician i's elasticity of demand e_Q^i is a function of the number M of physicians within the community and of the vector $(p_i, \bar{p}_i)$ of prices they

charge. Since a symmetric equilibrium is being sought, $p = p_1 = p_2 = \ldots = p_M$ may be substituted for $(p_i, \overline{p}_i)$. Thus e_Q^i is appropriately written as $e_Q^i(p, M)$. The signs of its partial derivatives are:

$$\frac{\partial e_Q^i}{\partial p} < 0 \tag{6.03}$$

and

$$\frac{\partial e_Q^i}{\partial M} > 0. \tag{6.04}$$

The first inequality stems from the weak assumption that as price increases demand becomes increasingly elastic. Linear demand curves, for example, have this property. The second sign stems from the argument of the preceding sections: an increase in the number of physicians may lead to less elastic demand for each physician.

Substitution of p for p_i in (6.02) gives:

$$p = \frac{c\, e_Q^i(p, M)}{1 + e_Q^i(p, M).} \tag{6.05}$$

If, for a given M, (6.05) can be solved for p, then that p is the market equilibrium price for the symmetric equilibrium $p = p_1 = p_2 = \ldots = p_M$. This is because (6.05) is a rewrite of (6.02) for the special case of a symmetric equilibrium. Equation (6.05) is certain to have a solution if, for any given M, $e_Q^i(0, M) \geq -1$ and, for some price $p_+ > 0$, $e_Q^i(p_+, M) = -\infty$.[29] These are the nonstringent requirements that at zero price the demand for a physician's services be inelastic and that at some price p_+ the demand for his services be perfectly elastic. A physician's demand curve satisfies both these requirements if it is downward sloping and intersects both the price and quantity axes.

Suppose that an equilibrium price p* exists. If (6.05) is rewritten as

$$g(p^*, M) = p^* - \frac{c e_Q^i(p^*, M)}{1 + e_Q^i(p^*, M)} = 0, \tag{6.06}$$

then implicit differentiation gives the derivative of p* with respect to M:

$$\frac{dp^*}{dM} = -\frac{\frac{\partial g}{\partial M}}{\frac{\partial g}{\partial p^*}} = \frac{c \frac{\partial e_Q^i}{\partial M}}{(1 + e_Q^i)^2 - c \frac{\partial e_Q^i}{\partial p^*}} > 0 \tag{6.07}$$

The inequality follows from (6.03) and (6.04). Inequality (6.07) is the paper's main result. It states that an increase in the number of physicians within a community may cause the equilibrium price for physicians' services to rise.

This is a short-run result because the number of physicians M has been treated as exogenous. It, however, can be generalized to be a long run result as follows. Suppose initially that the market for physicians services is in full long run equilibrium. This means in particular that each community has an equilibrium number of physicians in it. Now suppose that the number of physicians in the entire nation increases.[30] Eventually after these additional physicians distribute themselves appropriately among the various communities within the country, a new long run equilibrium will be achieved. In this new equilibrium every community will have at least as many physicians as it did in the original equilibrium. Therefore the short run result is applicable: the increased number of physicians causes the equilibrium price in each community to rise. Consequently, if the short run result is valid, then an increase in the number of physicians nationally should cause increases throughout the nation in the prices that physicians charge.

7. Conclusions

This paper has developed a monopolistically competitive model of the market for primary physicians' services.[31] Its primary implication is that an increase in the number of physicians may cause physicians to increase the prices they charge consumers. The key step in the derivation is the explicit modeling of the demand each individual physician faces; without that no argument is possible concerning the effect that an increase in the number of physicians has on individual physicians' demand curves.

In the construction of this model I have necessarily made simplifying assumptions and thus have neglected factors that may be important. Four of these factors are as follows.

1. This model neglects the physician's ability to create demand and to alter the quality and personableness of his services. Evans [3,4], Evans, Parrish, and Sully [5], Gertman [11], Monsma [16], and Pauly [21] discuss the former and Sloan and Lorant [26] discuss the latter.

2. The physician within this paper's model maximizes only net income. A more satisfactory model would have the physician maximize the expected utility of net income and leisure. Inclusion of leisure in the analysis would tend to make the physician less likely to lower prices as his patient load increases. Whether this would offset the effects identified in this paper is an open question that can only be resolved empirically.

3. This paper's model considers the physician in isolation from hospitals. Pauly and Redisch [22] and Shalit [24] have shown that strong physician control of hospitals may enable physicians to earn increased incomes.

4. This paper has not analysed physicians' locational decisions. One of the factors, however, that affects a physician's decision to practice in a particular community is the equilibrium price for physicians' services in that community. Consequently within each community equilibrium price and the number of physicians are jointly determined. Therefore any econometric test of this paper's theory must involve simultaneous estimation of (i) the pricing model developed here and (ii) an appropriate locational model.

These comments concerning this paper's limits are meant as a cautionary note only. They do not compromise the point of the paper: maximizing behavior on the part of physicians and consumers is logically consistent with a direct relation between the number of physicians within a community and the prices they charge.

FOOTNOTES

[1]Between 1965 and 1974 the physician fee component of the consumer price index rose at an average rate of 6.0%. During the same period the consumer price index increased at an average rate of 5.6% per year. These statistics and the physician-population ratio statistics are from Tables 105, 111, and 708 of [29].

[2]Quoted from Table 2 (page 158) of Rheinhardt [23].

[3]The econometric studies of Newhouse [18], Huang and Korapecky [12], and Newhouse and Phelps [20] have found that an increase in the physician-population ratio leads to a statistically significant increase in physicians' prices. They thus support the crude regional figures quoted above. The studies of Steinwald and Sloan [27] and Sloan [25], however, have given mixed results, i.e. depending on the speciality the relation between price and the physician-population ratio is direct, insignificant, or inverse.

[4]Sloan's paper [25] is a partial exception to this statement. He includes the physician-population ratio (PP ratio) in his specification of the demand function for a physician's services. He expected that an increased PP ratio would decrease the price that the physician can obtain for a given quantity of services. In his equation the PP ratio enters additively. This has the effect that an increase in the PP ratio shifts the demand curve towards the origin in a parallel manner. This shift causes the demand that the physician faces at any given price to become more elastic and thus leads him to reduce price. The model presented in this paper suggests that a decrease in demand may do the opposite: make demand less elastic and lead him to raise price. As a consequence, Sloan's specification must be judged too restrictive to test this paper's model.

[5]Also see Newhouse and Sloan [19].

[6]Notice that my interest is in analyzing the firm's demand curve, not the industry demand curve. Empirical work has focused on measuring the industry demand function for physicians' services, not the demand function individual practitioners face. To my knowledge the only exception to this is unpublished work that Newhouse and Sloan mentioned in [19].

[7]The choice of a week as the unit of time is arbitrary.

[8]Note that this formulation is appropriate even though the most common reason for a consumer to switch physicians may not be dissatisfaction over price, but dissatisfaction over quality.

[9]If each equation (2.03) and (2.04) is divided through by N and the system is solved for $(N_1/N, \ldots, N_m/N) = (\rho_1, \ldots, \rho_m)$, then $(\rho_1, \ldots, \rho_m)$ is the vector of steady state probabilities for the Markov process that describes each patient's choice of physician.

[10]A substantial number of weeks may elapse before the expected quantity demanded approaches the equilibrium quantity demanded. In the short run demand is less elastic than it is in the long run.

[11]Empirical studies of why consumers choose one physician instead of another appear to be rare. One paper that does consider this question is Booth and Babchuk [1]. It generally confirms my description: an individual tends to depend on the recommendations of those friends and relatives whom he perceives to have superior expertise about the health care system.

[12]That this model is rudimentary and preliminary must be emphasized. Nevertheless my intuition is that the conclusion of this model is quite robust to changes in its specification, cf. footnotes 13 and 16.

[13]The model could have been specified to allow individuals to not only exchange stories about their personal physicians, but also to exchange hearsay stories about physicians other than their own personal physician. I do not think this change would affect the conclusion.

[14]This account is perhaps an optimistic view of how people gossip about people. An alternative interpretation of the model avoids this objection. Individual j can only repeat what he has heard about physician i if he remembers his name. Moreover, j only remembers the physician's name if he possesses the threshold level of information η.

[15]It is "one plus..." because j tells his friend about both his own physician and those physicians for whom $\theta_i^t \geq \eta$.

[16]A modification of the model that gives the same result is to assume that information exhibits increasing returns to scale. Specifically, assume that the usefulness of the information that θ_i^t represents is not proportional to θ_i^t, but is proportional to $f(\theta_i^t)$ where f is a strictly convex function. Individual j, when asked, tells everything he recalls, i.e. there is no threshold value. The total value of this information to the friend who asked for the information is $\Sigma_{i=2}^{M} f(\theta_i^t)$. As M increases, this value decreases because the average value of each component θ_i^t decreases. The convexity of f then implies that an increase in M causes a decrease in the value of the information. This analysis is confirmed by simulation:

Average Value of Information

M	$\delta = .125$	$\delta = .167$
10	81.5	19.4
15	12.6	6.21
25	6.77	4.17
35	4.81	3.61

where $f(\theta_i^t) = (\theta_i^t)^2$.

[17]The model I present here is not a global optimization on the part of the consumer. As Table 1 shows, as the number of physicians in the community increases, the cost of search for a new physician becomes high. In the model I present here the consumer only changes his search strategy as the cost of search increases. He does not change his probability s_i of switching. A full optimization model would allow the consumer to optimize his decision to switch jointly with his search strategy.

[18]Notice that the assumption that each consumer's quality rating is independent of other consumers' ratings does not imply that a consumer can not learn useful information by asking another consumer for a recommendation. This is because the independence of ratings does not stem from an independence in the way consumers perceive a physician's characteristics: his location, his availability, his personal manner, the amenities of his office, his technical qualifications, etc. Rather it stems from the manner in which consumers evaluate the relative importance of the several characteristics. For example, a particular location may be convenient for one consumer and very inconvenient for another.

[19]Within the context of this model, individual i's belief that every physician charges the price p^o is rational because, as Section 6 shows, a perfectly symmetric equilibrium, where every physician charges the same price, exists for this model.

[20]Individual i's subjective distribution is assumed to remain fixed throughout his search for a new physician. He is not permitted to learn about and revise $F(\chi)$ as he samples.

[21]See, for example, DeGroot [2] or Lippman and McCall [13].

[22] See Lippman and McCall [13].

[23] A class of distribution for which $\partial e^1_\omega / \partial u^* > 0$ everywhere is:

for $\chi \geq 0$

$$F(\chi) = 1 - \frac{1}{(\chi + 1)^\alpha}$$

where α is a positive parameter. A class of distributions for which $\partial e^1_\omega / \partial u^* < 0$ everywhere are the uniform distributions: for

$$F(\chi) = \frac{1}{\beta-\alpha}\chi - \frac{\alpha}{\beta-\alpha}$$

where α and β are parameters such that $\beta > \alpha$.

[24] Gastworth [10] has made a similar argument in a slightly different context.

[25] For the normal distribution $\partial e^1_\omega / \partial u^* < 0$ everywhere even though it has an unbounded tail.

[26] If a distribution's probability density function does not have an unbounded right tail, then its right tail must either be truncated or be approximatable as the right hand tail of a triangular distribution. If the density function is truncated at $\chi = \chi_o$, then examination of (5.06) shows that as χ approaches χ_o from the left the first term, $\{1-F(\chi)\} F''(\chi)$, approaches zero while the second term, $\{F''(\chi)\}^2$, remains positive. Therefore $\partial e^1\omega/\partial u^* < 0$ for χ close to χ_o. If, on the other hand, the density function $F'(\chi)$ is not truncated on the right but smoothly approaches zero as χ approaches χ_o from the left, then $F'(\chi)$ may be approximated by the right triangular density function

$$G'(\chi) = \frac{2\beta}{(\beta-\alpha)2} - \frac{2}{(\beta-\alpha)^2}\chi$$

where α and β are parameters picked such that (i) $\chi < \chi_o$ implies $G'(\chi) > 0$, (ii) $G'(\chi_o) = 0$, and (iii) the left hand derivatives of F' and G' are equal at χ_o. After some tedious calculation:

$$\frac{\partial e_{\omega}^{1}}{\partial u^*} = - \frac{2\gamma p_1}{(\beta - \chi^*)^2} < 0$$

where $\chi^* = {}^* + \gamma p_1$. Thus in either case $\partial e_{\omega}^{1} / \partial u^*$ is not positive everywhere.

[27] Frech and Ginsburgh [8], Newhouse [18], Sloan [25], and Steinwald and Sloan [27] all assume that physicians maximize profits.

[28] This is the concept of Nash equilibrium.

[29] Assume that $e_Q^i(p, M)$ is continuous. If $e_Q^i(0, M) \geq -1$, and $e_Q^i(p_+, M) = -\infty$, then (i) some $p' > 0$ exists such that

$$p' - \frac{ce_Q^i(p', M)}{1 + e_Q^i(p', M)} < 0$$

and (ii) some $p'' > 0$ exists such that

$$p'' - \frac{ce_Q^i(p'', M)}{1 + e_Q^i(p'', M)} > 0$$

The intermediate value theorem therefore implies that a solution to (6.05) exists. If a nonsymmetric equilibrium were being sought, then a more complicated fixed point argument would be necessary.

[30] The number of physicians nationally is exogenous because of the restricted capacity of medical schools. This means there is not free entry into the medical profession. Consequently, long run equilibrium does not imply zero profits for physicians.

[31]The reason it is appropriate only for primary care physicians is that the market for referral specialists' services may differ in three ways: (i) their services may be almost completely covered by third party payors, (ii) referring physicians may be well informed concerning comparative qualities and prices, and (iii) oligopolistic interaction may take place among members of the more esoteric specialities.

References

1. A. Booth and N. Babchuk, "Seeking Health Care from New Resources," Journal of Health and Social Behavior, 13 (1972), 90-99.

2. M. DeGroot, Optimal Statistical Decisions, (New York: McGraw-Hill, 1970).

3. R.G. Evans, Price Formation in the Market for Physician Services 1957-69, (Ottawa: The Queens Printer, 1972), Ch. 3.

4. R.G. Evans, "Supplier-Induced Demand: Some Empirical Evidence and Implications", in The Economics of Health and Medical Care, ed. by M. Perlman (London: Macmillan Press, Ltd.: 1974), 162-73.

5. R.G. Evans, E.M.A. Parish, and F. Sully, "Medical Productivity, Scale Effects, and Demand Generation," Canadian Journal of Economics, 6 (1973), 376-93.

6. M.S. Feldstein, "The Rising Price of Physicians' Services," Rev. of Economics and Statistics, 52 (1970), 121-33.

7. H.E. Frech, III and P.B. Ginsburgh, "Physician Pricing: Monopolistic or Competitive: Comment," Southern Economic Journal, 38 (1972), 573-77.

8. H.E. Frech, III and P.B. Ginsburgh, "Imposed Health Insurance on Monopolistic Markets: A Theoretical Analysis," Economic Inquiry, 13 (1975), 55-70.

9. V.R. Fuchs and M.J. Kramer, Determinants of Expenditures for Physicians Services in the U.S. 1948-68, (Washington, D.C.: National Center for Health Services Research and Development, DHEW Publication No. (HSM) 73-3013, 1973).

10. J.L. Gastwirth, "On Probabilistic Models of Consumer Search for Information," Quarterly Journal of Economics, 90 (1976), 38-50.

11. P.M. Certman, "Physicians as Guiders of Health Services Use," in Consumer Incentives for Health Care, ed. by S.J. Mushkin (New York: Prodist, 1974), 362-84.

12. L.F. Huang and O. Koropecky, "The Effects of the Medicare Method of Reimbursement on Physicians' Fees and on Beneficiaries Utilization," Vol. II, Part I (Washington, D.C.: DHEW, Soc. Sec. Admin., S.S. Pub. No. 92-73 (10-73), 1973).

13. S. Lippman and J. McCall, "The Economics of Job Search: A Survey, Part I," Economic Inquiry, 14 (June 1976), 155-189.

14. R.T. Masson and S. Wu, "Price Discrimination for Physicians Services," Journal of Human Resources 9 (1974), 65-79.

15. W.F. Massy, D.B. Montgomery, and D.G. Morrison, Stochastic Models of Buying Behavior, (Cambridge: The MIT Press, 1970).

16. G.N. Monsma, "Marginal Revenue and the Demand for Health Services," in Empirical Studies in Health Economics, ed. by H. Klanman (Baltimore: John Hopkins Press, 1970), 145-60.

17. P. Nelson, "Information and Consumer Behavior," Journal of Political Economy, 78 (1970), 311-29.

18. J.P. Newhouse, "A Model of Physician Pricing," Southern Economics Journal, 37 (Oct. 1970), 174-83.

19. J.P. Newhouse and F.A. Sloan, "Physician Pricing: Monopolistic or Competitive: Reply," Southern Economic Journal, 38 (April 1972), 577-80.

20. J.P. Newhouse and C.E.Phelps, "New Estimates of Price and Income Elasticities of Medical Care Services," in R. Rosett, ed., The Role of Health Insurance in the Health Services Sector, (New York: National Bureau of Economic Research, 1976), 261-320.

21. M.V. Pauly, "Information and the Demand for Medical Care" in Theoretical Studies in Health Economics, ed. by J.Hixson and L. Krystaniak (forthcoming in 1977).

22. M.V. Pauly and M. Redisch, "The Not-for-Profit Hospital as a Physicians Cooperative," American Economic Review, 63 (1973), 87-99.

23. U. E. Reinhardt, "Alternative Methods of Reimbursing Non-institutional Providers of Health Services," in Controls on Health Care: Papers of the Conference on Regulation in the Health Industry January 7-9, 1974 sponsored by Institute of Medicine (Washington, D.C.: National Academy of Sciences, 1975), 139-174.

24. S.S. Shalit, "A Doctor-Hospital Cartel Theory," Journal of Business, 50 (1977), 1-20.

25. F.A. Sloan, "Physician Fee Inflation: Evidence from the Late 1960's," in The Role of Health Insurance in the Health Services Sector, ed. by R.N. Rosett, (New York: National Bureau of Economic Research, 1976), 321-53.

26. F.A. Sloan and J.H. Lorant, "The Allocation of Physicians' Services: Evidence on the Length-of-Visit," Q. Rev. of Economics and Business, 16 (1976), 85-103.

27. B. Steinwald and F.A. Sloan, "Determinants of Physician Fees," Journal of Business, 47 (Oct. 1974), 493-511.

28. L.C. Telser, "The Demand for Branded Goods as Estimated from Consumer Panel Data," Review of Economics and Statistics, 44 (1962), 300-24.

29. United States Bureau of the Census, Statistical Abstract of the United States 1976, 97th edition, (Washington, D.C.: Department of Commerce, 1976).