Network Incentives in Managed Health Care

Ching-to Albert Ma

Boston University
Boston, MA 02215
ma@bu.edu
and
Hong Kong University of Science and Technology
Hong Kong
albertma@ust.hk

Thomas G. McGuire

Harvard Medical School
Boston, MA 02115
mcguire@hcp.med.harvard.edu

This paper introduces a theory of network incentives in managed health care. Participation in the plan's network confers an economic benefit on providers; in exchange, the plan expects compliance with its protocols. The network sets a target for the number of outpatient visits in an episode of care. A provider failing to satisfy the target may be penalized by the plan's attempt to direct patients to other providers within its network. There is an equilibrium in which every provider in the network uses the target. We test the theory by observing behavior of providers before and after the introduction of managed mental health care in a large, employed population. Managed care consisted of price reductions, utilization review, and creation of a network. Quantity per episode of care fell sharply after initiation of managed care. We identify a network effect in our empirical work. The results indicate that in this case, network incentives account for most of the quantity reduction due to managed care.

A research center grant from the National Institute of Drug Abuse (P50 DA10233) for the Brandeis/Harvard Research Center on Managed Care and Drug Abuse Treatment and a grant from the National Institute of Mental Health (K05 MH01263) provided the support for these analyses. Didem Bernard and Yong Weng provided excellent research assistance. We are grateful to Dan Ackerberg, Randy Ellis, Richard Frank, Haiden Huskamp, Kevin Lang and Michael Manove for their helpful comments. We are also grateful to current and former officials of the Group Insurance Commission in Massachusetts, Charles Slavin, Deanna Greene, and Mary Funari for their help in obtaining access to the data and in answering the authors' queries. We thank the editor, coeditor, and two referees for their comments.

Journal of Economics & Management Strategy, Volume 11, Number 1, Spring 2002, 1–35

1. Introduction

The large majority of the privately insured in the US, roughly 75%, receive health care under some form of management by their health plan—a percentage that tripled in the eight years between 1987 and 1995.[1] *Managed care* clearly is a recent and important phenomenon. Perhaps, most importantly, the emergence of managed care in the health-insurance industry has been accompanied by lower costs. In 1996, US health care costs grew at the lowest rate in over 30 years, and federal officials and researchers credited managed care (American Health Line, 1998). While the evidence on the effect of managed care on the quality of care is mixed,[2] it is clear that managed care has revolutionized the control of moral hazard in health care.[3]

In the standard model of the health care market, consumers and health care providers are linked to the insurer by insurance and payment contracts. The insurance contract specifies the premium and any payments (copayments and deductibles) that have to be made by the consumer at the time of service; the payment contract specifies the terms by which health care providers are paid when services are supplied: reimbursement, per diem, or capitation. The financial incentives associated with insurance and payment contracts have been analyzed extensively in the theoretical and empirical literature (see, for example, Ellis and McGuire, 1993; Lewis and Sappington, 1998; Ma,

1. Jensen et al. (1997) report these numbers based on a survey of insurance plans from private employers. The growth of managed care is continuing. Morrisey and Jensen (1997) report that small employers, which until recently have clung to conventional insurance plans, are also now mostly offering managed care products. The US has two major public-health payment programs, Medicare for the elderly and Medicaid for the poor. As of the end of 1997, only about 14 percent of the elderly are in managed-care, as the federal government has been reluctant to coerce the elderly to change their form of health coverage (Medicare Payment Advisory Commission, 1998, p. 5). One year earlier, 8 percent of the elderly were in managed care plans. States, which administer the Medicaid program, have not shown the same reluctance to move the poor into managed care. The Health Care Financing Administration's web site reports that 40% of Medicaid enrollees were in managed care as of 1996. The number increased from 29% the year before.

2. Miller and Luft (1997) review the evidence comparing the quality of care in managed care organizations paid by capitation (a per-person per-year payment) and conventional fee-for-service medicine. There is evidence for higher quality on each side, without a clear pattern except that for some chronic illnesses, patients seem to fare less well in managed care. The effect of managed care on quality must be kept distinct from the effect of capitation. Higher or lower quality is not inherent in managed care, but derives from the incentives created by a capitation or other payment system. See Newhouse (1996). For a general review of the literature, see Glied (2000).

3. Rates of hospitalization are compared for HMO and non-HMO patients in Greenfield et al. (1992). See Miller and Luft (1994) and Shortell and Hull (1995) for a review. For recent studies that include reviews, see Gaskin and Hadley (1997) and Wholey et al. (1997).

1994; Ma and McGuire, 1997; Newhouse, 1996). Demand-side and supply-side cost sharing are supposed to induce the optimal trade-off between risk sharing and moral hazard—the tendency towards overconsumption of health care when consumers do not fully internalize treatment costs. Managed care, on the other hand, appears to be distinct from these financial incentives, and directly or indirectly attempts to influence the amount of treatment providers can supply or consumers may demand. While there is a wide range of observed managed-care practices, the purposes of many of them are quite obvious. For example, denial of care, utilization reviews, pretreatment authorizations, and second opinions are clearly explicit attempts to control the usage of medical care, through direct control on the supply, the demand, or both.

Nevertheless, almost all managed care plans use *networks* of providers. Consumers in such a plan must obtain covered care from those providers within the managed care network. When an out-of-network provider is used by a consumer, coverage may be significantly less, or absent. The use of a network of providers by the majority of managed care health plans poses a deeper and more difficult question. What does a managed care plan intend to achieve by drawing a distinction between in-network and out-of-network providers? What is gained by restricting patients' choice to a subset of doctors or hospitals contracting with the managed care plan?

In this paper, we model providers' incentives under a network, and set out a theory of how a network functions. In simple terms, a health care provider in the network may benefit from the flow of business that consumers of the managed care plan demand if she controls moral hazard on behalf of the health plan. Formally, we assume that a managed care plan sets a quantity target for a treatment episode. If a network provider's supply deviates from this target, then the plan attempts to direct patients who would like to use this provider to other providers. This network incentive is independent of, and may be complementary to, the financial incentives contained in the provider payment contract.

We test the model by measuring the power of the network effect associated with the introduction of managed care in a large employed population. As we have discussed and will explain further below, managed care consists of a set of tactics to control costs, so to measure the network effect, we must control for the effect of utilization review, price controls, and other factors affecting the quantity of health-care use.

A managed care plan may create a network to reduce prices paid per unit of services,[4] as well as to control quantity. Managed care companies of course may use their sheer size to exercise monopsony power, but theoretically, creating a network is unnecessary: a managed care company can simply implement price reductions to all providers. Perhaps, price reductions are somewhat easier to implement when providers are organized in a network. We are interested in studying the effect of network incentives on quantity supplied. If price is all that matters, then controlling for prices paid in a managed care plan would leave no other empirical effect of the network itself.

We use claims data from regimes before and after the introduction of managed mental-health care in an employed population in Massachusetts. We identify episodes of outpatient care and obtain the number of visits in each episode. The implementation of managed care in our setting involves a substantial price reduction from the previous regime. We find that the managed care regime depresses visits per episode even when price and other effects are controlled for; we label this remaining managed care effect a *network effect*.

Although the importance of a network as an incentive mechanism is unlikely to surprise practicing physicians, our reading of the literature has revealed very few rigorous discussions. The term "managed care" at one time referred to a staff-model health maintenance organization (HMO), such as Kaiser Permanente in the western part of the US, in which doctors work as employees of the organization. In such a setting, no new theory is needed to understand the mechanisms an employer has to monitor and control employees' performance: modern agency theory can explain employees' incentive to act in the interest of the firm, subject to hidden-action or hidden-information problems (Holmstrom, 1979; Harris and Raviv, 1979). Growth in managed care in the last decade has mostly come in the form of more loosely organized networks. A network consists of a subset of providers in a market who contract with the insurance plan. The contract specifies payment and other terms on which the providers may be reimbursed for covered services. Even some long-standing and well-known staff-model HMOs, such as Harvard-Pilgrim Plan in the Boston area, are converting from a staff to a network form. Perhaps more striking is the fact that the financial contract between providers and the plan often takes a simple form, such as a fixed price per unit of service, or per diem in the case of

4. Cutler et al. (2000) find that in the treatment of heart disease among the enrollees of one employer in different plans, the managed care effect is seen entirely on prices, and not at all on the quantity of care delivered.

hospitals. The financial incentives of the explicit contracts are often low-powered, and yet significant changes in providers' behavior have been observed.

As we have said above, a range of features of managed care has been documented, and many restrict quantities explicitly. Nevertheless, explicit quantity restrictions seldom appear to be binding. Outright denial of care is uncommon, leads to bad publicity, and certainly cannot account for much of the effect of managed care. In a survey of 2000 physicians conducted in 1995, Remler et al. (1997) found that while managed-care plans initially denied 3.4 percent of physicians' requests to hospitalize patients, two-thirds of these initial denials were reversed on appeal, and ultimately only 1 percent of hospitalizations were denied. For other procedures studied, the ultimate denial rates are also low, the highest being for requests for a mental-health referral, with an eventual denial rate of 3.0 percent.[5] This again casts doubt on whether much of the effect of managed care can be accounted for by these explicit restrictions.

A provider's payment contract with a managed care plan can also impose direct incentives to reduce care. A hospital, for example, might agree to be paid a fixed price for all baby deliveries; as a result, the hospital will have to worry about the Cesarean-section rates and the lengths of stay for a normal delivery.[6] Doctors or groups of doctors have been willing to take similar forms of risk-based contracts from managed-care companies in exchange for being responsible for providing health care to enrollees.[7] In the same survey of physicians just mentioned, Remler et al. (1997) reported that for all physicians, the mean percentage of patients for whom capitation is paid to the physician or to the group to which the physician belongs was only 13 percent. Given its bigger size, a managed-care plan should be in a better position to bear risks than a group of physicians. It is not surprising that the share of the risks borne by physicians is not very high.

5. Of course, the threat of denial may deter some requests, but physicians may also have other strategies for circumventing utilization review of this form, such as making an initial request for more than they think they really need.

6. Several years ago this would have simply been called "prospective payment"; it is a form of payment used by Medicare to pay hospitals since 1983, and since widely adopted by other payers.

7. Greenfield et al. (1992) found, on the basis of information on more than 20,000 patients, that after adjusting for patient characteristics, doctors or single-specialty groups paid by a fee-for-service policy hospitalized patients 41% more frequently than comparable physicians paid by capitation. See Hellinger (1996) or Newhouse (1996) for a recent review of this literature. The basic idea is that if doctors or other providers receive payment prospectively, independent of costs of services provided, they will have less incentives to give services, since they are not reimbursed at the margin for more care. Elements of prospective payment enter into some contracts with doctors, as we discuss further below.

Indeed, although the moral-hazard problem may necessitate imposing some risks on the providers, it is clear that if the incentives can be provided without exposing providers to risks, a superior allocation can be achieved.

In fact, low-powered payment contracts are very common. A fee-for-service contract based on "discounted fees" applies to 38 percent of physicians' patients; see Remler et al. (1997). Hellinger (1996) reports similar results from a survey in 1994–1995. Sixty-three percent of doctors contracting with managed care were reimbursed on a fee-for-service basis, some with unspecified withhold provisions. If the fee is above marginal cost, even if the fee is less than what they received prior to accepting the contract, this form of payment gives the doctor little incentive to reduce services.[8] Recent data collected by Newhouse et al. (2000) for HMOs representing almost 80,000,000 enrollees implies that the use of capitation contracts for at least the primary-care component of clinical practice might be becoming more widespread. They find that about 50% of enrollees were served by primary-care groups paid by capitation. It is unclear how these incentives matter at the physician level, since the groups taking capitation tend to be very large (with 26 or more members). Most other physicians and other services are not paid by capitation. It is evident that high-powered incentives in payment by health plans are not the main way by which physicians are driven to reduce spending.

A few recent pieces on the economics of networks have appeared in the industrial-organization literature. Jackson and Wolinsky (1996), and Kranton and Minehart (2000) have proposed formal models for considering trading mechanisms among networks of firms. The focus, however, has not been on the incentives of the network design; rather, the above papers attempt to understand the endogenous formation of trading partners in the form of a network to facilitate efficiency in trades.

Within the literature on the health-care industry, some formal analysis has taken place of the hospital and pharmaceutical markets, but largely centered on the issue of how networks endow a payer with the power to bargain for a better price. In pharmaceuticals, networks are called "formularies," and by restricting enrollees' choice to one or a few branded drugs within a class of competing drugs, HMOs and other plans can elicit bids from manufacturers at lower prices (Scherer, 2000). Dranove et al. (1993) called this "payer-driven competition" in the case of hospital services. When payers can direct

8. See also Gold et al. (1995).

patients to lower-priced hospitals, it increases hospitals' price elasticity of demand, lowering price. Town and Vistnes (1997) propose and test a model of payer hospital network formation based on an objective of minimizing average price.

Van Horn et al. (1997) apply *dependency theory* from sociology to the issue of networks of physicians in managed-care plans. According to dependency theory, by concentrating business among fewer providers, a network makes these providers more dependent on the plan, and therefore more likely to accommodate the plan's demand. An empirical implication of this theory is that the larger is a plan's share of business with a physician, the more likely he or she is to comply with the plan's desires. Van Horn et al. study physician practice patterns in Arizona; they find that the more is a physician's dependence on managed care for business, the lower the charges incurred for a hospital stay, controlling for (among other things) whether the particular patient is paid by managed care or not, a result confirmed in Bernard's (2001) replication of their study.[9]

Our paper fits into the small but growing literature on managed care and control of moral hazard in health care.[10] At a theoretical level, managed care is usually conceived in abstract terms. In Baumgarder's (1991) early paper, and later in Ramsey and Pauly (1997), managed care controls quantity by setting a limit on the quantity that may be used for a particular condition. How this rationing works is not specified. An alternative approach is taken by Keeler et al. (1998), who model managed care as setting a shadow price to consumers, but again, the rationing device is left at an abstract level. Empirical papers on managed care and cost control typically study the overall effect of a managed-care change without separately identifying the effects of the components of managed care. In research closely related to ours, for example, Goldman (1995) and Goldman et al. (1995) studied the joint effect of a managed-care initiative with a benefit expansion, network creation, and price reductions.[11]

9. Bernard (2001) uses the same medical conditions as the earlier study.

10. The economics literature concerned with adverse selection and managed care is also growing rapidly, and stems from the observation that the rationing devices used in managed care are not contractible, posing special challenges for regulation. For recent papers, see Che and Gale (1997), Encinosa and Sappington (1997), Frank et al. (2000), Glazer and McGuire (2000), and Wolinsky (1997). The empirical literature on adverse selection is discussed in Cutler and Zeckhauser (1997).

11. Physicians can also form networks in order to coordinate sales to managed-care plans and other large buyers. Supplier-created networks for market power are a distinct phenomenon. See Haas-Wilson and Gaynor (1998) for discussion of this from an antitrust perspective. The any-willing-provider legislation debate bears on the network issue. Physicians, pharmacists, and other providers have complained about being shut

Within a model of imperfect competition, Section 2 analyzes physician response to two of the strategies employed by managed care plans: price setting and network incentives. The effect of administered prices on quantity per episode is ambiguous, but creation of a network has a clear, powerful, and negative effect on quantity. Section 3 describes the managed care plan that generated the data for this study. Descriptive results are contained in Section 4. Our approach to identifying network effects is set out in Section 5, with results presented in Section 6. Section 7 discusses our findings and draws the implications for research and policy.

2. Managed Care and Physician Behavior

Almost all papers on the health market recognize, as Arrow (1963) first pointed out, the noncontractibility of health status ("outcome"), as well as the noncontractibility of patient and physician actions. Various forms of provider and insurance contracts can be interpreted as attempts to solve problems introduced by the missing markets due to noncontractibility when a third party pays for health care to protect consumers against the risk of health-care use. In our earlier paper (Ma and McGuire, 1997), we show that provider payment and insurance mechanisms are insufficient, in general, to induce the efficient action of physicians. We also point out that controlling the flow of business to a provider gives a plan a new tool to affect physician behavior and this may aid the plan in inducing efficient physician actions.

This section contains a model of this demand-control process.[12] We must first construct a model of patient-physician interaction.[13] Our basic framework is a Hotelling-type model of imperfect competition and characterize physician behavior before price setting or networks. Since physician services are nonretradable, a physician with market power has some quantity-setting power ("influence") even without any additional assumptions. We then introduce managed care in two

out of plan-created networks, and argued that if they meet the terms of the offered contract, they should be allowed to serve the plan's consumers. Our paper makes clear that the reasons for creating a network go beyond price concerns and deal with quantity issues that are fundamentally noncontractible. Any-willing-provider legislation is inherently contradictory. Admitting any willing provider changes the nature of the contract between the plan and the providers.

12. See for example Ma and Riordan (2001), Che and Gale (1997), and Dranove and Satterthwaite (2000).

13. In the literature, it has been argued that physicians can set quantity to some degree, since they sell a nonretradable service (Farley, 1986); physicians can "induce demand" via some advertising-like activity (Rice and McCall, 1983); physicians can undertake more or less "effort" eliciting a demand response (Ma and McGuire, 1997). See McGuire (2000) for review and discussion.

steps. First, the managed-care plan can set prices. This is insufficient to fully achieve the plan's objectives, because physicians retain some ability to set quantities. Next we give the plan the authority to use a network, which consists of the plans' ability to affect the flow of patients to that provider.

Two providers offer health care to consumers, whose preferences for the firms' services differ. We let a unit of consumers distribute uniformly on a line of unit length, and put a provider at each end of the line. Consumers are insured, and their common coinsurance rate is denoted by θ, where $0 < \theta < 1$; in other words, a consumer is responsible for θ of his expenditure. Although a consumer picks a provider freely, the quantity of services that he receives from a provider is decided by that provider.[14] A consumer that is located at x has a utility $U(Q) - \theta PQ - tx$ if he consumes Q units of health care from provider 1 and pays a price P per unit of health care, where U is a strictly increasing and strictly concave function, and t can be regarded as the "transportation" cost or taste parameter that captures the extent of product differentiation between firms.[15] Similarly, if the consumer obtains Q units of services from provider 2, his utility is $U(Q) - \theta PQ - t(1 - x)$ when provider 2's price is P. Each provider's common and constant marginal cost of production is set at c.

The basic game can be described in two stages. In the first stage, each of the two providers simultaneously chooses the quantity of health care service, Q, and a unit price, P. In the second stage, each consumer picks a provider. If a consumer chooses a provider that has announced (P, Q), then he gets Q units of health care service and pays a total of θPQ; the balance of $(1 - \theta)PQ$ will be paid by the insurer to the provider. We regard the game with a passive payer accepting the (P, Q) pairs offered by physicians as a pre-managed-care era. Later, we will consider a game in which the active insurer sets the unit price of the services, but each provider will still be able to choose the quantity of services.

Suppose that provider i has chosen a unit price P_i and Q_i, $i = 1, 2$. Suppose that some consumer located at x is just indifferent between choosing provider 1 and provider 2; then x is given by $U(Q_1) - \theta P_1 Q_1 - xt = U(Q_2) - \theta P_2 Q_2 - (1 - x)t$. Therefore, provider 1's demand function is given by

$$x = \frac{[U(Q_1) - \theta P_1 Q_1] - [U(Q_2) - \theta P_2 Q_2]}{2t} + \frac{1}{2}.$$

14. Physician services are noncontractible from the point of view of the plan. Furthermore, because services are nonretradable, in the absence of payer interference a physician with market power sets quantity as well as prices.

15. Provider 1 is located at point 0; provider 2, at point 1.

Provider 1's profit is

$$\pi_1 = (P_1 - c)Q_1 \left(\frac{[U(Q_1) - \theta P_1 Q_1] - [U(Q_2) - \theta P_2 Q_2]}{2t} + \frac{1}{2} \right).$$

To characterize an equilibrium, consider provider 1's first-order conditions with respect to both prices and quantities:

$$\frac{\partial \pi_1}{\partial P_1} = Q_1 \left(\frac{[U(Q_1) - \theta P_1 Q_1] - [U(Q_2) - \theta P_2 Q_2]}{2t} + \frac{1}{2} \right)$$
$$- (P_1 - c)Q_1 \frac{\theta Q_1}{2t} = 0,$$
$$\frac{\partial \pi_1}{\partial Q_1} = (P_1 - c) \left(\frac{[U(Q_1) - \theta P_1 Q_1] - [U(Q_2) - \theta P_2 Q_2]}{2t} + \frac{1}{2} \right)$$
$$+ (P_1 - c)Q_1 \frac{U'(Q_1) - \theta P_1}{2t} = 0.$$

In a symmetric equilibrium, firms choose the same price-quantity pair. So the equilibrium can be characterized by the above first-order conditions after setting the providers' strategies to be identical.

Simplifying the first-order conditions, we have

$$P - c = \frac{t}{Q\theta},$$
$$t + Q[U'(Q) - \theta P] = 0.$$

Combining the above, we derive

$$U'(Q) = \theta c,$$

which is the standard moral-hazard overconsumption result. Notice that the equilibrium quantity each consumer receives maximizes each consumer's net benefit as if each consumer's cost of quantity were namely, $cU(Q) - \theta Qc$. In our model, since a firm can set the price per unit service quantity as well as the quantity, each firm effectively sets the total price (PQ) of a service of Q units to be supplied to each consumer who uses the firm. Our result indicates that competition among firms will lead to a maximization of the net benefit of each consumer by a choice of quantity, and then the price per unit of quantity is set to reflect the elasticity of demand facing the firm. The nature of this result can be related to Spence (1975) and more recently to Ma and Burgess (1993). The quantity of service, Q, in our model can be thought of as quality in a standard model where the firm picks a price and a quality of its product. Spence demonstrates the fundamental point that generally the market allocation yields an efficient level of quality if consumers' marginal and average valuations of quality are identical. In our model, this identity is guaranteed, since the demand function is separable in Q and the total price θPQ that consumers pay. Hence, the equilibrium level of Q can be expected to be efficient with respect to the subsidized cost of θc per unit of Q.

As noted earlier, managed care often means price regulation; moreover, the regulated price is likely to be lower than the equilibrium price without regulation. So we now consider a model in which each provider's price per unit of quantity is predetermined by the insurer. Here, each provider competes by choosing only the quantity of service for each patient, Q. The results above can readily be adapted to analyze the equilibria. Given that providers choose only quantities, for a given pair of prices, we can examine the first-order conditions with respect to quantity.

To characterize the equilibrium, we assume the two quantities set by the providers to be equal. Using this equilibrium condition, we totally differentiate to obtain

$$[U'(Q) - \theta P]\, dQ + Q[U''(Q)\, dQ - \theta\, dP] = 0$$

and

$$\frac{dQ}{dP} = \frac{\theta}{U'(Q) - \theta P + U''(Q)} < 0,$$

where the inequality follows from $U'(Q) - \theta P < 0$ and the concavity of U. Thus, in our model, when a regulator reduces the price from the equilibrium level, both firms will tend to increase their quantities.[16]

The comparative-statics result just described may not be completely robust. In fact, one can easily imagine that a reduction in price will lead to a fall in quantities. For example, some providers may exit, reducing the market supply and affecting the elasticity. Or the actual demand function may not satisfy the separability assumption that we have used here, so that the derivative of equilibrium quantity with respect to the (regulated) price may not have a definite sign. In any case, our point in the paper is that managed care cannot be explained

16. The empirical finding in health economics that a lower regulated price is associated with a larger quantity of services per patient has suggested to some authors that physicians are "inducing demand" to maintain "target income." This is not a reasonable explanation in a market in which physicians serve patients from many payers (McGuire and Pauly, 1991). Furthermore, the negative dQ/dP emerges in a very simple model of physician behavior, without special motives or power of physicians. Note that dQ/dP would still be negative even if patient coinsurance were a constant and not a share of price.

by a change in price alone, and our regressions will need to control for the "price" effects.

Now we describe a model of managed care. We understand by managed care those specific interventions that a payer or insurer may use to affect the quantities that a provider may choose for the consumers. These interventions are to be distinguished from financial incentives. That is, we define managed care as a direct intervention on quantities. In practice, utilization reviews, preadmission authorizations, and second-opinion requirements, as well as various approvals for physicians seeking to administer certain treatments or procedures, are such interventions. Here, we will not directly model specific interventions, since we would like the model to be general enough for our empirical applications. We characterize a managed care regime by a pair (Q^*, ϕ), where Q^* is a quantity target and ϕ is the probability that a consumer will be directed by the managed-care company to a provider that prescribes a quantity closer to Q^*. After the managed care parameters Q^* and ϕ are determined, each provider decides on a quantity of treatment. When a patient calls to obtain approval for treatment, the managed care company may direct the patient to a physician whose quantity is closest to Q^*. If the consumer is not directed, then he obtains treatment from his proposed provider. The magnitude of ϕ measures the strength of managed care. A high value of ϕ means that a provider will get very few patients if she does not prescribe the target quantity. Managed care here imposes an explicit process of quantity restriction. A physician is penalized for not following the plan quantity target (which may be set up either explicitly or implicitly) by a reduced flow of patients.

The managed care network mechanism should be interpreted broadly. Formally, we have considered a target and a redirection probability. In practice, patients' illness severities vary, and it is unrealistic to require that the same target apply to all patients. One interpretation of the target in the model is that it represents an average level of use for a population of patients within some specified period of time, say, half a year. This interpretation avoids a rigid target on any particular patient. Nevertheless, to satisfy the target, over time a provider may have to adjust his treatment style. Furthermore, due to differences in case mix, different targets may be implemented on providers with different types of patients. The redirection probability in our model can also be interpreted broadly. In practice, the flow of patients among providers in any network may be due to physician referrals. The redirection of patients in our model can be interpreted as a managed care protocol of referrals. Instead of being under a liberal, unconstrained policy, physicians may have to consult special procedures when patients are referred for consultation or for appropriate services. According to this interpretation, if a physician does not follow the target, the referral protocol will be biased against him. Some managed care plans, such as in the setting to be examined below, require a preapproval before a new episode of care can begin. The redirection probability can be implemented by specific authorization procedures that selectively steer patients towards certain providers who are more willing to implement the target.[17]

The consequence of the quantity target is easy to derive. Indeed, there exists a threshold, say ϕ^*, such that for all $\phi > \phi^*$, each physician will choose Q^* in an equilibrium. Let the price be fixed at P. Suppose that provider 2 picks Q^*. Then if provider 1 chooses Q^*, its profit is $(P - c)Q^*/2$. If provider 1 changes its quantity to any Q not equal to Q^*, its demand function is

$$(1 - \phi)\left(\frac{[U(Q_1) - \theta P Q_1] - [U(Q^*) - \theta P Q^*]}{2t} + \frac{1}{2}\right),$$

and its profit is

$$(P - c)Q_1(1 - \phi)\left(\frac{[U(Q_1) - \theta P Q_1] - [U(Q^*) - \theta P Q^*]}{2t} + \frac{1}{2}\right).$$

In the managed-care regime, if provider 1 does not pick Q^*, let $Q(Q^*)$ be the optimal quantity that maximizes provider 1's profit given that provider 2 picks Q^*, which can be obtained from the first-order condition of the profit function above. Notice that since ϕ enters the profit function in a multiplicative way, $Q(Q^*)$ is independent of ϕ, whence our omitting ϕ as an argument in the best response function. By the envelope theorem, provider 1's maximum profit when it does not pick Q^* is strictly decreasing in ϕ. So for all values of ϕ sufficiently close to 1, the maximum profit must be less than $(P - c)Q^*/2$. Therefore, for ϕ sufficiently close to 1, it is an equilibrium for both firms to pick Q^*.

We can also find the threshold ϕ^*. This is the minimum value of ϕ for which provider 1's profit from picking Q^* is just equal to that from $Q(Q^*)$. So its value can be obtained from the following equation:

$$(P-c)Q_1(Q^*)(1-\phi^*) \times \left(\frac{[U(Q_1(Q^*)) - \theta P Q_1(Q^*)] - [U(Q^*) - \theta P Q^*]}{2t} + \frac{1}{2}\right) = \frac{(P-c)Q^*}{2}.$$

17. For example, when answering patients' inquiries, a health plan may choose to supply information on a select subset of providers.

Our theory of network incentives introduces an additional effect on provider behaviors.[18] As we have mentioned above, managed care usually means the implementation of explicit quantity restrictions as well as price reductions. We have derived the effects of both price reduction and quantity restriction (in terms of a target and probability of rejecting treatment by provider not using the target). The empirical work to follow will attempt to identify the network effect on quantity.

3. The Setting

The empirical study in the paper uses data of four years of health care costs of state employees in Massachusetts for treatment of mental health and substance abuse (MHSA). Health insurance for state employees and their families is the responsibility of a state agency, the Group Insurance Commission (GIC) of the Commonwealth of Massachusetts, the largest employer-based health care payer in the state. The GIC has contracted with a combination of traditional indemnity insurers as well as HMOs since the middle of the 1970s. Between fiscal years 1989 and 1993, the State Hancock Plan, administered by John Hancock Mutual Life Insurance Company, was the indemnity plan for GIC enrollees. In addition, during this time, the GIC contracted with 14 HMOs (staff and network models) and offered them as enrollment options to employees.

The GIC decided to introduce more aggressive managed care in its indemnity program beginning in July 1993 (fiscal year 1994). Part of the change consisted of carving out the MHSA benefit. The carve-out consisted of a separate contract written to a behavioral health-care management company that would be responsible for administration of the MHSA care for all enrollees in the indemnity plan. Hancock, under its own contract, remained responsible for all other health care.[19] After a competitive bidding process, Options Mental Health Inc.

18. We do not formally model the optimal network. Here, we simply hypothesize that the health plan implements a certain target by a redirection probability. The optimal choice of a managed-care network requires a theory about the trade-off between the costs of restricting patient services and its benefits. Consumers *ex ante* likely prefer more diversity, and a network that is too restrictive will be unattractive to them. To the health plan, the benefit of a network likely depends on the degree of competitiveness of the suppliers' market.

19. Employers elect to use carve-out plans to deal with moral-hazard and adverse-selection problems in insurance markets and to improve the value of money spent in the care area. In the case of the GIC, the primary stated goal was not to save money but to increase the value of state spending and to deal with "risk fragmentation" and related selection problems. See GIC, Request for Proposal, 1992, especially pp. 1–2. For more general discussion of the role of carve outs, see Frank et al. (1996).

(Options) was selected as the winner from among five behavioral health-care applicants.

Important dimensions of the new benefit plan for enrollees and how it should be managed were specified by the GIC. Options was to set up a network of inpatient and outpatient providers who were screened and qualified by Options and who would provide adequate geographic coverage for enrollees. Options was to conduct utilization reviews. If an enrollee received care from a network provider, precertification had to be obtained from Options by calling a toll-free telephone number before care began (except in emergencies).[20] For in-network care, Options reviewed treatment at ten visit intervals, beginning with the tenth visit. Inpatient care was also subject to continuing review. A clinical case manager was responsible for conducting reviews and awarding precertification. Options was free to set a fee schedule to providers according to their training (MD, PhD, MA).

The benefit plan to enrollees was improved over the previous coverage. Before the carve out, outpatient mental-health and substance-abuse coverages were respectively 50% and 80% of allowed charges, with respective limits of $1500 and $2500 of plan payments per year (after a small deductible was met). After the carve-out, enrollees could retain 50% coverage if they saw a nonnetwork provider, but only up to 15 visits, and subject to the fee limits imposed by Options.[21] After the carve-out, for a network provider, the enrollee would pay nothing for the first four MHSA visits, $20 for visits 5–25, and $40 thereafter, with no limit (except a $1,000,000 lifetime cap). From the demand side, the benefit changes in July 1993 would tend to increase costs. Options was expected to offset the increased costs due to reduced demand-side cost sharing by negotiating for better prices, utilization review, and inducing providers to become more cost-effective.

GIC paid Options a fee per insurance contract (individual or family) to cover administrative expenses. In addition, the contract between GIC and Options contained incentive features related to access, reporting requirements, quality, and cost targets. Options's administrative fee would be reduced if spending exceeded the target. The penalty to Options was set at 20% of any excess spending up to a maximum penalty of 4% of estimated spending. Options therefore had some incentives to keep spending below the target.

20. Precertification can be interpreted as a form of potential patient redirection. Options has the opportunity to advise or convince the patients to use other providers at the precertification stage.

21. Options paid 50% of its allowable fee. The client was responsible for any charge exceeding the allowable fee.

Experience of the GIC with the behavioral-health carve-out has been the subject of some previous research. Ma and McGuire (1998) examine aggregate expenditures for two years before and after the carve-out, and show that price and quantities fell about 30–40% for both inpatient and outpatient care. Huskamp (1999) studied outpatient spending using a version of the two-part model employed in the RAND Health Insurance Experiment (Manning et al., 1987; Newhouse et al., 1993). The probability of use (measured quarterly) and the spending condition on use both fell after the introduction of managed care. Huskamp concluded that managed-care techniques (pricing, utilization review, provider selection), taken together, dominate the stimulus from the improved benefit design, but the contribution of the components of managed care were not studied. Merrick (1998) carefully compared the claims for treatment of major depression before and after managed care, and found that patients discharged from hospitals with major depression were more likely to be seen by an outpatient provider following discharge in the carve-out era, an indication that for this seriously ill group, appropriate services were more likely to be provided after managed care.

4. Data and Descriptive Results

4.1 Episode Construction

The original data consist of dated health-insurance claims with units-of-service and payment information, as well as provider identification numbers and scrambled patient identifiers, for approximately 40,000 persons who were continuously covered by the GIC through the four years of data. Patient demographic and diagnostic information is on the claims. After cleaning the claims to eliminate duplications and adjustments, we created a price and a quantity variable for each claim. In few cases in which units of service were missing, we used the dollar payment fields to create a quantity by dividing total payment by $100. Prices were converted to 1995 values using the medical-care component of the CPI. We then summarized prices and quantities by patient and by month. For each patient and for each month, we kept track of up to three providers, ranking them by the volume of their payments from that patient in that month.

From the monthly data we created episode files. The purpose of defining an "episode" is to group together a sequence of health care uses into a natural decision making unit. Ideally, an episode of treatment would correspond closely to the services used in connection with an episode of illness. In well-known work on episodes in general health care, Keeler and Rolph (1988) group uses of medical services together in an episode with the aid of clinical algorithms. In mental-health care, the common approach, which we follow, is to define episodes by gaps in treatment.[22] We begin an episode for a patient in the first month of contact with a provider in the data, and end that episode when there is a gap of three months or more in reported treatment. If the patient is treated again after the three-month gap, we call this a new episode. Our data include some episodes that are complete, i.e., for which the start and the end date are contained within the four years of observation, as well as those that are left-truncated, right-truncated, or both.

Using the monthly summaries, we find the provider with the largest volume of billing during the episode and attribute the episode to that provider. Episodes are useful for describing provider behavior. As Keeler and Rolph note, patients typically initiate care, but "once a patient has decided to see a doctor, that doctor helps to decide how much to spend on care during an episode" (1988, p. 341).

Identifying the characteristics of providers was problematic in some cases. Some provider numbers had more than one provider type (MD, psychologist, clinic, etc.). In these cases we selected the type reported most frequently. In the post period, provider type reporting changed and became much less informative, so in most cases we used the type from the pre period. Data from the post period included two fields that contain information on whether the claim constituted an in-network or out-of-network claim. We found these to be unreliable at the claims level, often being contradictory to one another, and failing to validate the payments we would expect for in-network and out-of-network care. We therefore did not classify providers according to whether they were in or out of network.

4.2 Descriptive Results

Table I presents some basic statistics on rates of outpatient utilization in the four years of data from the sample of continuously enrolled individuals. The percentage of the population who are users and the number of visits per user fall in the post period. The fourth year of the data consists of only nine months of data, artificially depressing the use statistics for that period. When looking at annual data, the

22. See Keeler et al. (1988) and Kessler et al. (1980) for episode research on the effects of benefit design and HMO-style managed care respectively. Ellis (1985) contains a review of the issues associated with defining episodes in mental health. Other empirical papers using episodes in mental health include Haas-Wilson et al. (1989) and Deb and Holmes (2000).

TABLE I.
ANNUAL RATES OF OUTPATIENT USE

	Pre-managed-care		Post-managed-care	
Measure	FY 1992	1993	1994	1995
Number of users	5042	5035	4329	3903
Percent of population	12.8	12.7	11.0	9.9
Visits per user	14.4	14.3	11.7	8.5
Payments per user (1995$)	1375	1332	958	668

Note: Payments are in 1995 dollars adjusted for the medical-care component of the CPI.

rate of use in any year is made up of new users that year and persons who continue use from a previous period. Earlier research on mental health and managed care found that managed care (of an HMO type) had a large effect on the rate of continuation but not a large effect on the rates of initiation of care (Manning et al., 1986; Kessler et al., 1980). We checked this in our data and found that using annual data, the rates of both initiation of care and continuation of care fell in the post-managed-care period, although the drops in rates were both relatively small.[23]

All classes of providers experienced post-managed-care price decreases, as shown by the average prices paid (in 1995$) per visit in Table II. Options decided that for a standard outpatient 50-minute psychotherapy visit, psychiatrists would be paid $95, psychologists $85, and social workers $70. Other providers also were subject to fee schedules. The averages for fiscal years 1994 and 1995 are less than these regulated amounts for these providers because psychotherapists also provide some visits of a shorter duration, such as a visit to monitor medication, for which a lower fee applies. Most outpatient treatments in the data, however, were of the 50-minute-hour type. After the carve-out the average price for a visit dropped $35 in real terms for a psychiatrist, and $40 for a psychologist.

Table III shows the number of episodes and average number of visits pre and post according to a number of patient characteristics.

23. To make a fair comparison, we defined two periods, each of nine-month duration pre and post, centered on the midpoint of the pre and post periods. During the pre period, 70.8 percent of the users in the nine months before July 1992 continued to use in the nine months post July, 1992. During the post period, 66.1 percent of the users in the nine months prior to July 1994 continued to use in the next nine months. Of new users, in the pre period, 3.8 percent of those who did not use in the first nine month period pre did use in the second nine month period pre, compared to 3.5 percent in the post regime.

TABLE II.
AVERAGE PRICE PER OUTPATIENT VISIT BY PROVIDER TYPE AND YEAR

	Price ($)					
					Pre	Post
Provider Type	FY 1992	1993	1994	1995	1992–1993	1994–1995
Psychiatrist	120	107	81	77	113	79
Clinic	128	115	73	65	121	69
Social worker	100	86	69	68	93	68
Psychologist	126	110	80	77	118	78
Other	120	94	74	70	107	72

Note: Payments are in 1995 dollars adjusted for the medical-care component of the CPI.

Episodes are dated according to their starting dates.[24] The average number of visits fell across the board. In these descriptive tables we have not taken into account the left and right censoring of the episode data. Table IV compares the provider-type information pre and post. Providers differ in the average number of visits, but all providers reduced the average number of visits per episode substantially.

In some of our empirical analysis below, we will be concerned with the change in individual providers' behavior, and use a fixed-effects model to estimate that change. To do so requires a sufficient number of observations on each provider pre and post. Table V reports the number of episodes we have for each provider in the pre and post period and over all four years. For the pre episodes alone, 1434 providers had just one episode, 608 had two, and so on. Table V tells us that if we want to confine the analysis to providers with at least three episodes pre and post, we will be down to several hundred providers out of the original sample of about 3800.

Figure 1 graphs the average number of visits per episode according to the start date of the episode. Several things are notable from the figure. Spikes in January 1992 and January 1993 (months 7 and 19, respectively) are likely to be explained by the resetting of benefit limits that occurred on an annual basis in the pre period. Many long-term users evidently either began treatment or renewed billing for ongoing treatment in January. The spike at the first month of the data is probably an artifact. People "starting" in our data in July 1991 consist of both actual starters and continuing users from previous periods, and

24. The decrease in the number of visits per episode is much greater than the decrease in visits per year shown in Table I, since some of the visits occurring in the post period are attributed to episodes initiated in the pre period.

TABLE III.
EPISODE AND PATIENT INFORMATION

Patient Characteristics	Number of Episodes	Average Visits Per Episode Pre	Post
Sex:			
Male	5892	17	7
Female	8820	22	8
Age:			
0–17	1716	13	7
18–34	1595	22	8
35–44	3609	25	9
45–54	5016	20	8
55–59	1870	17	7
Relation:			
Employee	8340	23	8
Spouse	3940	19	8
Dependent	2432	14	7
Diagnosis:			
Anxiety	4789	23	8
Mood	2608	21	7
Psychosis	331	18	5
Substance abuse	442	23	9
Other	6542	18	8

these apparently have a high average number of visits per episode. Setting these three odd months aside, it is clear from the figure that the number of average visits per episode is smaller in the post (25+) than in the pre period (24 and before).

Figure 2 graphs the *hazard rate* of termination after any particular visit in an episode. The hazard rate in the post period is above the

TABLE IV.
EPISODES AND PROVIDER TYPE

Provider Type	Number of Providers	Number of Episodes	Average Visits Per Episode Pre	Post
Psychiatrist	926	3400	19	6
Clinic	530	3229	15	5
Social worker	635	1596	27	11
Psychologist	780	2660	25	10
Other	926	3787	19	8
Total	3797	14672		

TABLE V.
EPISODES PER PROVIDER

Number of Episodes	Pre	Post	All Years
1	1454	975	1667
2	618	397	742
3	294	188	390
4	195	102	259
5	128	82	173
6 to 10	228	152	390
11 to 20	54	39	156
21 and above	20	18	56
Total providers	2991	1953	3834

rate in the pre period with the exception of very large numbers of visits, the occurrences of which are not very common. If the utilization-review impact at 10 and 20 visits were important, we would expect to see an elevated hazard at around 10 and 20 in the post period. Although there are small peaks at 10 and 20, these are not significantly higher than the hazard rates in the vicinity, and furthermore, the differences are of small magnitude. There is no evidence from this analysis that the 10-visit check points have decreased utilization. There is an elevated hazard at 15 in the post period, probably due to a benefit design effect: for out-of-network care, coverage stops after 15 visits.

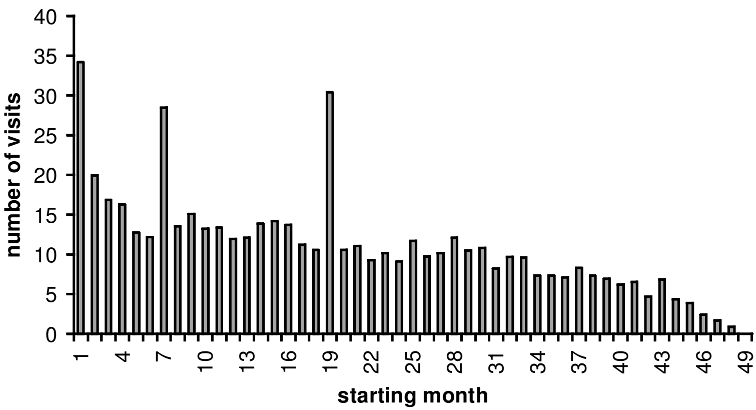

FIGURE 1. EFFECT OF STARTING MONTH ON THE DURATION OF AN EPISODE

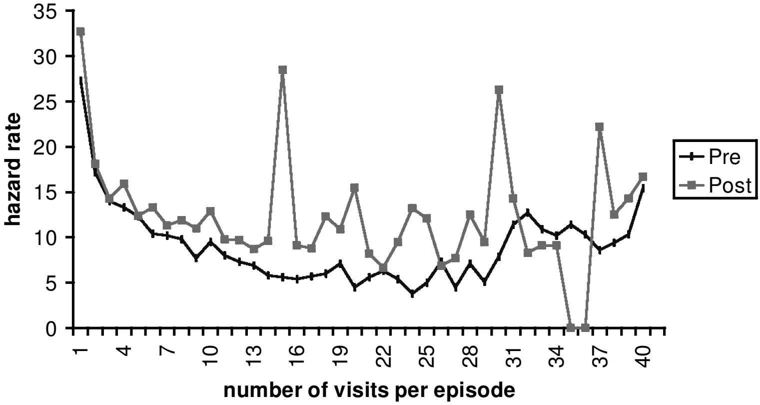

FIGURE 2. HAZARD RATE OF TERMINATION: PRE AND POST

5. Empirical Approach for Identifying the Network Effect

5.1 Identification

In a pre-post design we must isolate a program effect from other trends in the data. A matched control group observed over the same period of time not experiencing the managed-care intervention would be ideal for identifying a trend, but no such group exists. Instead, in our basic specification, we estimate a linear time trend. We then allow managed care to impact this time trend separately for each major provider type. We conduct various specification checks on our control for time trends.

Besides controlling for trends, we face the challenge of decomposing the effect of a single intervention into its parts. We are most interested in the incentives associated with the network established by Options; these incentives came into play simultaneously with other changes: improvements in the benefit, reduction of prices paid to providers, and implementation of utilization review. Table VI lists the components of the intervention and summarizes how we intend to separate empirically the network effect from the other effects.

First, we conclude, based on the hazard-rate information contained in Figure 2, that the utilization-review effect cannot be significant. While this is consistent with other findings in the literature on managed care, it is obviously an extreme assumption. Any true utilization-review effect will be falsely attributed to network incentives in our empirical work.

TABLE VI.
Hypothesized Effects of Managed Care on Number of Visits per Episode

Instrument	Hypothesized Direction	How Identified
Utilization review	−	Very small, based on examination of hazard of stopping
Administered prices	±	Use variation in imposed price change
Benefit design	+	Part of Pre-Post design
Network effects	−	Part of Pre-Post design

Options imposed price cuts on providers, which may influence utilization. As we saw in Section 2, in response to a price cut, the profit-maximizing provider will change quantity. Fortunately, we can identify a price effect in our data by comparing the response of providers whose prices changed by different amounts as the result of Options price regulation. Specifically, psychiatrists whose prices were already $95 (in 1995 dollars) during the pre period did not experience a price cut. There is no price effect of managed care on these providers. A psychiatrist whose price was higher than $95 in the pre period did experience a price cut of a magnitude we can measure. We use this variation to identify the price effect in a specification check. Because we use the pre price as a covariate, we restrict our sample to 11,853 episodes in which providers had at least one episode in the pre period.

We cannot separate the benefit-design effect (certainly positive) from the network effect (predicted to be negative). Our estimate of the network effect is too low when these two are grouped together. The network effect is measured using a *pre-post* set of dummy variables, taking on the value of 1 during the post period and 0 otherwise, interacted with the time trend. These capture the network effect, and any other effect of managed care not separately identified.

5.2 Specification and Estimation

We describe here our basic model specifications and the estimation methods. After presenting the results for the basic specifications in the next section, we also conduct a series of specification checks. Our first basic specification follows the approach common in health econometrics (Jones, 2000) and uses the number of visits as the dependent variable. The number of visits can be viewed as a count, so alternatively, we employ the flexible and general negative-binomial density for the distribution of visits conditional on the x variables.[25] In both specifications, we control for a series of patient demographic and diagnostic characteristics, and for a January effect by a dummy variable indicating that start month for an episode. Additionally, we include a dummy variable indicating the first month in the data, to control for the apparently large number of visits per episode used by the continuing users. In both the least-squares and the negative-binomial specifications, we control for types of provider.

Patients may have more than one episode, and providers may see many patients. In the case of the least-squares visit model, we therefore apply the Huber-White method (White, 1980) to take account of the possible interdependence among the error terms and to obtain robust confidence standard errors. The count model is estimated with maximum likelihood in trends, including a correction for clustering.[26] One of our specification checks contends with censoring by using only "completed episodes." Our data is censored on the left (in the pre period) and on the right (in the post). Since the problem applies equally to both time periods, a pre-post comparison ignoring the censoring, as is done in least-squares estimates, will be of interest.

As our theory of network incentive indicates, the network effect is about providers' changing behavior. In practice, however, different providers may have different practice styles. Instead of causing change in behavior among the providers, the managed-care plan may simply allocate more patients to those providers who already practice a more conservative style. In other words, reduction in the average number of visits per episode can be achieved by simply changing providers. Our first task, therefore, is to see if the overall pre-post effect is due to providers changing or changing providers. We settle this by comparing models of visits per episode on a number of patient characteristics and on pre-post with the same model, containing a fixed effect for each provider in the data. The second set of estimates tell us how much the average provider has changed, and we can compare this with the total change from the first regression to see how much of the total is accounted for by providers changing.

25. See Deb and Holmes (2000) for a recent application of a count model to the number of visits in behavior health care.

26. Both sets of estimates were done in STATA 5, using the reg and rbneg procedures with the cluster option.

6. Results

6.1 Basic Specification

Table VII reports our basic specifications for the visits and count-of-visits models. The data include all 11,853 episodes from providers with at least one episode in the pre period. Censoring is ignored. The R^2 is an impressive 0.440 in the visits model. Independent variables are grouped in categories to assist in interpretation. There is a powerful downward trend in the data, evident in the coefficient of time (months) in both the least-squares (LS) and the negative-binomial regressions. The magnitude is easy to interpret in the linear model. The coefficient of −0.249 implies that the number of visits

TABLE VII.
Network and Price Effects: Basic Specifications

		Visits (Least Squares)		Count of Visits (Negative Binomial)	
Set of Variables	Variable	Estimate	*t*-Value	Estimate	*t*-Value
Time trend	Time (months)	−0.249	−7.30	−0.0166	−6.70
Patient variables	Age	0.0839	0.66	0.00812	0.77
	Age squared	−0.00303	−2.21	−0.000200	−1.75
	Male	−2.27	−4.96	−0.0930	−3.29
	Employee	6.71	4.39	0.284	2.34
	Spouse	4.37	2.76	0.210	1.68
Diagnosis	Anxiety	2.36	4.39	0.112	3.37
	Mood	2.71	3.88	0.0784	1.77
	Psychosis	−0.471	−0.35	−0.200	−1.97
	Substance abuse	3.42	2.22	0.197	2.88
Special months	January	9.49	13.68	0.569	16.74
	First month	15.75	15.29	0.666	14.47
Provider main effects	Psychiatrist	12.65	6.56	−0.0676	−0.45
	Clinic	10.92	5.63	−0.0435	−0.28
	Social work	19.71	9.85	0.380	2.59
	Psychologist	18.66	9.88	0.363	2.47
	Other	10.63	5.51	−0.126	−0.81
Post-managed care change in trend by provider (network effect)	Psychiatrist	−0.127	−1.98	−0.0332	−6.61
	Clinic	−0.0140	−0.22	−0.0351	−6.87
	Social work	−0.296	−3.65	−0.0157	−2.73
	Psychologist	−0.330	−4.48	−0.0261	−5.53
	Other	−0.00947	−0.13	−0.0284	−3.62
	Obs.	11,853			
	R^2	0.440			

in an episode is falling by one-quarter of a visit per month throughout the period of the data. If we take a midpoint of the pre period at 20 visits, this would mean that by one year after managed care, the number of visits per episode would fall to 14 ($24 \times -0.25 = -6$) by time trends alone. In what follows, we conservatively estimate the impact of managed care networks as any effect over and above this already large downward time trend. We acknowledge that some of the estimated negative time trend may be due to managed care being anticipated, or its effect coming in gradually.

Some other covariates are important. Age has a quadratic effect on number of visits per episode peaking at a young age in the visits model and in early adulthood in the count-of-visits model. Males make fewer visits than females; employees make more visits than spouses and children (the omitted category). The diagnostic variables are groupings of more detailed codes, with "other" as an omitted category. Psychosis is a serious illness, but not very common in an employed population, and apparently is treated with episodes with fewer visits, possibly indicating that medication is substituted for therapist time for this group. The dummy variables for January and for the first month of the data are both positive and highly significant.

The next group of variables in the basic specification is the provider main effects. The model does not contain a constant term, so we can include a dummy variable for each of the five provider types. Social workers and psychologists conduct episodes with the largest number of visits, probably reflecting their emphasis on psychotherapy as opposed to drug treatment. The relative position of this important set of variables is similar to the count regression.

We are most interested in the set of variables labeled "Change in trend by Provider" in Table VII. We have estimated a change in trend for each provider type separately. Specifically, in addition to the variable "time," which takes on a value of 1–45 for the 45 months in the data, we have added a variable "post time" equal to zero during the months prior to managed care, and equal to 1–21 for the 21 months in the data after managed care. (This variable was multiplied by the dummy variables indicating each provider type to create the five interactions.) The interpretation of each of these variables is the estimated change in the trend for that provider type. Begin with the estimate −0.127 for psychiatrists in the linear model. This coefficient indicates that the downward trend in visits per episode accelerated after managed care for psychiatrists' patients. For each 12 months in post time, the number of visits per episode fell by about 1.5 visits (12×0.127).

In the linear model, three of the provider types—psychiatrists, social workers, and psychologists—were characterized by an accelerated downward trend. Each of these three provider types generally represents professionals in office practice. Clinics and other providers had no significant effect. Without pushing this difference too far (because it is not consistent across all specifications we checked), we would expect professionals to be affected by the network incentives we describe in this paper, and the myriad of organizations included in the other two provider categories to be less well suited to the model. In the linear visit model, the estimated impact for psychologists and social workers is slightly more than twice that for psychiatrists. Longer-term psychotherapy may be more responsive than medication-related treatment to incentives introduced by managed care, in an interesting parallel to the finding that demand for psychotherapy is more responsive to cost sharing (Frank and McGuire, 2000). The magnitude of the estimated fall in visits for these groups (recall, starting from a larger base) is 3.5–4.0 visits over the first year of managed care.

The negative binomial regression for the basis model yields estimates that are very consistent in sign (though not always in magnitude) with the linear model. The time trend and provider interactions are negative and significant for all provider groups. We do not find the intuitively appealing difference in the effect for the "professionals" versus the clinics and other providers that emerged in the linear visit model.

6.2 Specification Checks

The first check is to verify that the change in the number of visits per episode is due to a change in provider behavior. The alternative hypothesis is that the managed-care company channeled patients to different (less costly) providers. If this were true, even if no provider changed (and no incentives were active), visits per episode would fall. We investigated this by estimating two models of visits per episode, including fixed effects in one, while dropping all other provider variables. To make the two regressions comparable, we estimated them both on almost 5000 episodes from providers who have at least three episodes in each of the pre and post periods. These are the providers for whom we have enough data to reliably estimate the specification with fixed effects.[27] In the second and fourth columns in Table VIII, we

27. Although the minimum number of episodes providers have in this regression is three, these providers may have other potential contracts with the managed-care

TABLE VIII.
CHANGING PROVIDERS OR PROVIDERS CHANGING EPISODES FROM PROVIDERS WITH THREE OR MORE EPISODES PRE AND POST (N = 4990)[a]

	LS		Negative Binomial	
Estimate	Total Effect	Provider Change Effect	Total Effect	Provider Change Effect
Trend	−0.161	1.266	−0.017	−0.017
	(−3.30)	(5.47)	(−4.22)	(−4.54)
Changes in trend:				
Psychiatrist	−0.287	−0.107	−0.044	−0.033
	(−3.58)	(−1.11)	(−5.39)	(−4.55)
Clinic	−0.249	−0.094	−0.043	−0.037
	(−3.30)	(−0.98)	(−6.01)	(−4.41)
Social worker	0.012	−0.526	0.0061	−0.240
	(0.13)	(−2.4)	(0.60)	(−2.22)
Psychologist	−0.103	−0.284	−0.012	−0.204
	(−1.31)	(−2.36)	(−1.54)	(−2.74)
Other	−0.290	0.0095	−0.045	−0.030
	(−3.18)	(0.10)	(−3.36)	(−2.73)
Fixed effects	No	Yes	No	Yes

[a] t statistics in parentheses.

reestimated the basic specifications for the LS and negative binomial models respectively. Table VIII reports the main coefficients of interest. We call these the "total effect" regressions because they include a provider-change effect (within provider category) as well as a change in behavior of providers. The third and fifth columns report estimates after including about 300 fixed effects in both models—one for each provider in the data. The estimates in these columns comprise only a change in provider behavior. In the LS models, the estimated coefficients on the change in trend for each provider are generally negative, as in our basic specification. There is no clear pattern, however, on comparing the total and provider-change columns. In the case of the negative-binomial models, the results emerge more clearly. Coefficients tend to be estimated more precisely, and the provider-change effect appears to be about three-quarters of the total effect.

company. We must, however, caution the reader that dropping providers who have less than three episodes may potentially introduce a selection problem. The similarity in the estimates for the key variables in Tables VII and VIII suggests that this problem is not severe. We did not conduct a formal test of the similarity of the models estimated with and without fixed effects, as we are interested in both.

Tables IX and X reproduce in column 1 the key estimates from the basic model in Table VII, for the linear and the negative-binomial specification respectively, and then report how these estimates are affected by a series of specification checks. Column 2 in Tables IX and X adds a quadratic term to the time trend. In the linear model (in Table IX), the quadratic term itself is not significant. The magnitude of the estimated network effect for psychiatrists, social workers, and psychologists is not appreciably affected, though the estimated t statistics fall. In the negative-binomial regression, the squared quadratic term is significant, reduces the significance of the linear trend, and alters the sign of all the coefficients on the post-time provider variables. In this specification, the quadratic term is picking up the accelerated reduction in visits per episode following the imposition of managed care. Column (3) allows the time trend variable to differ for each provider type (i.e., there are five different time trends). Results for psychiatrists and psychologists are basically unaffected, but the estimate for social workers is altered.

Column 4 adds ten new variables, a main effect of price, and an interaction of price with provider. The purpose of these variables is to see if providers experiencing a large price decrease responded differently to the imposition of managed care than others, and if this might account for some of the effect of managed care. The price-fall effect was only estimated to be significant for social workers (it was positive, implying that social workers whose price was reduced increased visits per episode after managed care). This finding is consistent with some research in health economics, but since it appears only for this one set of providers, we do not put much weight on the result. More importantly, the estimated effects of our managed care impact variables are basically unaltered in either the linear or the negative binomial specification (with the minor exception of the psychiatrist coefficient in the linear model).

Column 5 adds a large number of variables capturing more detailed diagnostic information, and adds a (0, 1) variable indicating whether the patient had an inpatient claim within three months of the outpatient episode. These additional variables have little effect on the coefficients of interest. In column 6 we take the specification in column 5 and estimate it only for episodes that are *complete*, that is, that begin in month 4 or later, and end in month 42 or earlier. The coefficient for psychiatrists in the linear model falls in magnitude and significance, but with this exception, the results for the other provider groups hold steady in terms of magnitude and significance.

TABLE IX.
SPECIFICATION CHECKS: LINEAR MODEL[a]

	1 Basic Model	2 Specification: Add Quadratic Time Trend	3 Allow Separate Time Trend by Provider	4 Add Price Main Effect and Interact with Provider Type	5 Add Detailed Diagnosis and Inpatient Indicator	6 Diagnostic Detail and Inpatient Complete Episodes
Time (months)	−0.249	−0.231		−0.0169	−0.231	−0.251
	(7.3)	(−1.9)		(−6.96)	(−6.92)	(−7.21)
Time squared		−0.000738				
		(−0.17)				
Post time:	−0.127	−0.0929	−0.185	−0.106	−0.126	−0.0885
psychiatrist	(1.98)	(−0.45)	(−1.84)	(−1.61)	(−2)	(−1.39)
Post time:	−0.014	0.0202	−0.237	0.0206	−0.017	−0.0747
clinic	(0.22)	(0.1)	(−2.54)	(0.28)	(−0.27)	(−1.12)
Post time:	−0.296	−0.262	0.0442	−0.377	−0.307	−0.206
social worker	(3.65)	(−1.24)	(0.245)	(−4.4)	(−3.85)	(−2.34)
Post time:	−0.33	−0.296	−0.274	−0.335	−0.345	−0.354
psychologist	(4.48)	(−1.42)	(−2.15)	(−4.89)	(−5.18)	(−5.01)
Post time:	−0.00947	0.0245	0.212	−0.0293	−0.0218	0.013
other	(0.13)	(0.12)	(1.62)	(−0.42)	(−0.3)	(0.182)
No. of obs.	11853	11853	11853	11853	11853	7903

[a] t statistics in parentheses.

TABLE X.
SPECIFICATION CHECKS: BINOMIAL MODEL[a]

	1 Basic Model	2 Specification Add Quadratic Time Trend	3 Allow Separate Time Trend by Provider	4 Add Price Main Effect and Interact with Provider Type	5 Add Detailed Diagnosis and Inpatient Indicator	6 Diagnostic Detail and Inpatient Complete Episodes
Time (months)	−0.0166	0.00977		−0.0169	−0.0151	−0.0169
	(−6.7)	(1.01)		(−6.96)	(−6.39)	(−5.99)
Time squared		−0.00107				
		(−2.81)				
Post time:	−0.0332	0.0161	−0.0341	−0.0325	−0.0326	−0.0388
psychiatrist	(−6.61)	(0.857)	(−4.61)	(−6.11)	(−6.58)	(−6.18)
Post time:	−0.0351	0.0144	−0.0382	−0.0344	−0.0348	−0.0544
clinic	(−6.87)	(0.758)	(−4.78)	(−5.03)	(−6.77)	(−7.96)
Post time:	−0.0157	0.0334	0.0238	−0.274	−0.0178	−0.0217
social worker	(−2.73)	(1.81)	(2.5)	(−4.32)	(−3.14)	(−2.8)
Post time:	−0.0261	0.0237	−0.0337	−0.0252	−0.0269	−0.0418
psychologist	(−5.53)	(1.28)	(−5.16)	(−5.19)	(−5.83)	(−6.66)
Post time:	−0.0284	0.0209	0.00695	−0.0302	−0.0294	−0.0408
other	(−3.62)	(1.13)	(0.662)	(−2.31)	(−3.92)	(−5.13)
No. of obs.	11853	11853	11853	11853	11853	7903

[a] t statistics in parentheses.

7. Discussion

Health care costs are the product of a price and a quantity. In the past several years, virtually all health plans in the private and public realms have set limits on the prices they pay for health care professionals' services, and the price effects of managed care are evident (Cutler et al., 2000). Controlling quantity has in many respects proved more difficult. Numerous tools are in use: supply-side cost sharing, direct quantity limits, and incentives created by networks. Network effects are subtle, potentially powerful, and the least understood.

Previous research has emphasized the effect of network creation on the ability of a managed care plan to extract price concessions from providers. In this paper, we construct a model to show that a network can create incentives for a provider to rein in the quantity of services they supply to patients, over and above any effect due to price changes associated with a network. In the imperfectly competitive market characterizing physician and other health care provider services, the network threat of patient diversion can have a powerful effect on provider's choice of treatment.

Implementation of the managed care plan studied here was associated with a decrease in the quantity of services supplied to patients, in spite of continued payment to providers on a fee-for-service basis, relatively unintrusive utilization review, and, notably, a significant reduction in demand-side cost sharing that, by itself, would increase quantity. We interpret this drop in use as being due to providers' desire to stay in the good graces of the health plan—a network effect.

Study of a network effect calls for attention to a shortcoming in the literature on physician incentives. Virtually all theoretical papers on provider supply employ a monopoly model, even if in some cases the model is initially motivated by a discussion of imperfect competition. Networks cannot be discussed without a specification of the nature of competition among physicians. Integrating network incentives into the literature on physician behavior will require that more attention be paid to the role of market structure in shaping physician incentives.

References

American Health Line, 1998, "Health Care Spending Reaches $1 Trillion Mark for First Time," January 13.

Arrow, K.J., 1963, "Uncertainty and the Welfare Economics of Medical Care," *American Economic Review*, 53 (5), 941–969.

Baumgardner, J., 1991, "The Interaction between Forms of Insurance Contract and Types of Technical Change in Medical Care," *RAND Journal of Health Economics*, 22 (1), 36–53.

Bernard, D., 2001, "The Impact of Managed Care on the Hospital Industry," Unpublished Dissertation, Boston Universty.

Che, Y.-K. and I. Gale, 1997, "Buyer Alliances and Managed Competition," *Journal of Economics & Management Strategy*, 6 (1), 175–200.

Cutler, D.M., M. McClellan, and J. Newhouse, 2000, "How Does Managed Care Do It?" *RAND Journal of Economics*, 31 (3), 526–548.

—— and R. Zeckhauser, 1997, "Adverse Selection in Health Insurance," NBER Working Paper 6017, Cambridge, MA, July.

Deb, P. and A. Holmes, 2000, "Estimates of Use and Costs of Behavioral Health Care: A Comparison of Standard and Finite Mixture Models," *Health Economics*, 9 (6), 475–490.

Dranove, D.W., M. Shanley, and W.D. White, 1993, "Price and Concentration in Hospital Markets: The Switch from Patient-Driven to Payer-Driven Competition," *Journal of Law and Economics*, 36, 179–204.

—— and M. Satterthwaite, 2000, "The Industrial Organization of Health Care Markets," in A.J. Culyer and J.P. Newhouse, eds., *Handbook of Health Economics*, North Holland.

Ellis, R.P. and T.G. McGuire, 1993, "Supply-Side and Demand-Side Cost Sharing in Health Care," *Journal of Economic Perspectives*, 7 (4), 135–151.

——, 1985, "Episodes in Mental Health: Issues and Literature Review," Unpublished Manuscript, Brandeis University.

Encinosa, W.E. and D.M. Sappington, 1997, "Competition among Health Maintenance Organizations," *Journal of Economics and Management Strategy*, 6 (1), 129–150.

Farley, P. J., 1986, "Theories of the Price and Quantity of Physician Services," *Journal of Health Economics*, 5, 315–333.

Frank, R.G. and T.G. McGuire, 2000, "Economics and Mental Health," in A.J. Culyer and J.P. Newhouse, eds., *Handbook of Health Economics*, North Holland, Chapter 14.

——, H.A. Huskamp, T.G. McGuire, and J.P. Newhouse, 1996, "Some Economics of the Mental Health Carve-Outs," *Archives of General Psychiatry*, 53, 933–937.

——, J. Glazer, and T.G. McGuire, 2000, "Measuring Adverse Selection in Managed Health Care," *Journal of Health Economics*, 19 (6), 829–855.

Gaskin, D.J. and J. Hadley, 1997, "The Impact of HMO Penetration on the Rate of Hospital Cost Inflation, 1985–1993," *Inquiry*, 34, 205–216.

Glazer, J. and T.G. McGuire, 2000, "Optimal Risk Adjustment in Markets with Adverse Selection: An Application to Managed Health Care," *American Economic Review*, 90 (4), 1055–1071.

Glied, S., 2000, "Managed Care," in A.J. Culyer and J.P. Newhouse, eds., *Handbook of Health Economics*, North Holland.

Gold, M., L. Nelson, T. Lake, and R. Berenson, 1995, "Behind the Curve: A Critical Assessment of How Little is Known about Arrangements between Managed Care Plans and Physicians," *Medical Care Research and Review*, 52, 307–341.

Goldman, D., 1995, "Managed Care as a Public Cost-Containment Mechanism," *Rand Journal of Economics*, 26, 277–295.

——, S.D. Hosek, L.S. Dixon, and E.M. Sloss, 1995, "The Effects of Benefit Design and Managed Care on Health Care Costs," *Journal of Health Economics*, 14, 401–418.

Greenfield, S., E.C. Nelson, and M. Zubkoff, W. Manning, R.L. Kravitz, A. Keller, A.R. Tarlov, J.E. Wave, Jr., 1992, "Variations in Resource Utilization among Medical Specialties and Systems of Care. Results from the medical outcomes study," *Journal of the American Medical Association*, 267 (12), 1624–1630.

Haas-Wilson, D. and M. Gaynor, 1998, "Physician Networks and Their Implications for Competition in Health Care Markets," *Health Economics*, 7, 179–182.

——, A. Cheadle, and R. Scheffler, 1989, "The Demand for Mental Health Services: An Episode of Treatment Approach," *Southern Economic Journal*, 56 (1), 219–232.

Harris, M. and A. Raviv, 1979, "Optimal Incentive Contracts with Imperfect Information," *Journal of Economic Theory*, 20, 231–259.

Hellinger, F., 1996, "The Impact of Financial Incentives on Physician Behavior in Managed Care Plans: A Review of the Evidence," *Medical Care Research and Review*, 53 (3), 294–314.

Holmstrom, B., 1979, "Moral Hazard and Observability," *Bell Journal of Economics*, 10, 74–91.

Huskamp, H.A., 1999, "Episodes of Mental Health and Substance Abuse Treatment under a Managed Behavioral Health Care Carve Out," *Inquiry*, 36 (Summer), 147–161.

Jackson, M. and A. Wolinsky, 1996, "A Strategic Model of Social and Economic Networks," *Journal of Economic Theory*, 71 (1), 44–74.

Jensen, G.A., M.A. Morrisey, S. Gaffney, and D.K. Liston, 1997, "The New Dominance of Managed Care: Insurance Trends in the 1990s," *Health Affairs*, 16, 125–138.

Jones, A., 2000, "Health Econometrics," in A.J. Culyer and J.P. Newhouse, eds., *Handbook of Health Economics*, North Holland.

Keeler, E.B. and J.E. Rolph, 1988, "The Demand for Episodes of Treatment in the Health Insurance Experiment," *Journal of Health Economics*, 7, 337–367.

——, W.G. Manning, J.D. Rumpel, and K.B. Wells, 1988, "The Demand for Episodes of Mental Health Services," *Journal of Health Economics*, 7 (4), 369.

——, J.P. Newhouse, and G. Carter, 1998, "A Model of the Impact of Reimbursement Schemes on Health Plan Choice," *Journal of Health Economics*, 17, 297–320.

Kessler, L.G., D.M. Steinwachs, and J.R. Hankin, 1980, "Episodes of Psychiatric Care and Medical Utilization," *Medical Care*, 8, 1219–1227.

Kranton, R. and D. Minehart, 2001, "A Theory of Buyer-Supplier Networks," *American Economic Review*, 91 (3), 485–508.

Lewis, T. and R.H. Sappington, 1998, "Using Subjective Risk Adjusting to Prevent Patient Dumping in the Health Care Industry," Manuscript, University of Florida.

Ma, C.A., 1994, "Health Care Payment Systems: Cost and Quality Incentives," *Journal of Economics & Management Strategy*, 3 (1), 93–112.

——, and J.F. Burgess, Jr., 1993, "Quality Competition, Welfare, and Regulation," *Journal of Economics*, 58 (2), 153–173.

——, and T.G. McGuire, 1997, "Optimal Health Insurance and Provider Payment," *American Economic Review*, 87 (4), 685–704.

—— and ——, 1998, "Costs and Incentives in a Mental Health and Substance Abuse Carve-out," *Health Affairs*, 17 (2), 53–69.

——, and M.H. Riordan, 2001, "Health Insurance, Moral Hazard, and Managed Care," *Journal of Economics & Management Strategy*, this issue.

Manning, W.G., K.B. Wells, and B. Benjamin, 1986, "Use of Outpatient Mental Health Care: Trial of a Prepaid Group Practice Versus Fee-For-Service," R-3277-NIMH, RAND Corporation.

——, J.P. Newhouse, N. Duan, E.B. Keeller, A. Leibowitz, and S. Marquis, 1987, "Health Insurance and the Demand for Medical Care: Evidence from a Randomized Experiment," *American Economic Review*, 77, 251–277.

McGuire, T.G., 2000, "Physician Agency," in A.J. Culyer and J.P. Newhouse, eds., *Handbook of Health Economics*, North Holland, Chapter 9.

——, and M.V. Pauly, 1991, "Physician Response to Fee Changes with Multiple Payers," *Journal of Health Economics*, 10, 385–410.

Medicare Payment Advisory Commission, 1998, "Health Care Spending and the Medicare Program: A Data Book," Washington.

Merrick, E.L., 1998, "Treatment of Major Depression Before and After Implementation of a Behavioral Carve-out Psychiatric Services," *Psychiatric Services*, 49 (12), 1563–1567.

Miller, R.H. and H.S. Luft, 1994, "Managed Care Plan Performance since 1980," *Journal of the American Medical Association*, 271, 1512–1515.

—— and ——, 1997, "Does Managed Care Lead to Better or Worse Quality of Care?" *Health Affairs*, 16 (5), 7–25.

Morrisey, M.A. and G.A. Jensen, 1997, "Switching to Managed Care in the Small Employer Market," *Inquiry*, 34, 237–248.

Newhouse, J.P., 1996, "Reimbursing Health Plans and Health Providers: Efficiency in Production versus Selection," *Journal of Economic Literature*, 34, 1236–1263.

——, 1993, *Free for All? Lessons from the RAND Health Insurance Experiment*, Harvard University Press.

——, J.L. Buchanan, H.L. Barlit, D. Blumenthal, 2000, "Managed Care: An Industry Snapshot," Department of Health Care Policy, Harvard Medical School, December.

Ramsey, S. and M.V. Pauly, 1997, "Structure Incentives and Adoption of Medical Technologies in HMO and Fee-for-Service Health Insurance Plans," *Inquiry*, 34, 228–236.

Remler, D.K., K. Donelan, R.J. Blendon, G.D. Lundberg, L.A. Leape, D.R. Calkins, K. Binss, and J.P. Newhouse, 1997, "What Do Managed Care Plans Do to Affect Care? Result from a Survey of Physicians," *Inquiry*, 34, 196–204.

Rice, T. and N. McCall, 1983, "Factors Influencing Physician Assignment Decisions under Medicare," *Inquiry*, 20, 45–56.

Scherer, F., 2000, "The Pharmaceutical Industry," in A.J. Cuyler and J.P. Newhouse, eds., *Handbook of Health Economics*, North Holland.

Shortell, S. and K. Hull, 1995 "The New Organization of Health Care Delivery Systems," in U. Reinhardt, ed., *Baxter II: Health Policy Review*, Ann Arbor, MI: Health Administration Press.

Spence, A.M., 1975, "Monopoly, Quality, and Regulation," *Bell Journal of Economics*, 6, 417–429.

Town, R. and G. Vistnes, 1997, "Hospital Competition in HMO Networks: An Empirical Analysis of Hospital Pricing Behavior," Unpublished.

Van Horn, R.L., L.R. Burns, and D.R. Wholey, 1997, "The Impact of Physician Involvement in Managed Care on Efficient Use of Hospital Resources," *Medical Care*, 35, 873–889.

White, H., 1980, "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity," *Econometrica*, 48, 817–830.

Wholey, D.R., J.B. Christianson, J. Engberg, and C. Bryce, 1997, "HMO Market Structure and Performance: 1985–1995," *Health Affairs*, 16, 75–85.

Wolinsky, A., 1997, "Regulation of Duopoly: Managed Competition vs Regulated Monopolies," *Journal of Economics & Management Strategy*, 6, 821–848.