Utilization Management and Cost Sharing Between Payers and Insurers of Health Care

Richard C. Lindrooth[1]
Research Assistant Professor
Center for Health Industry Management Studies
Kellogg School of Management
Northwestern University

Abstract

The tradeoff between the amount of risk held by a managed care organization and utilization management is often over-looked in policy discussions about managed care. A payer of health insurance can induce the managed care organization to engage in the desired degree of utilization management through cost sharing. Only when the payer of health insurance is the government, providers are perfect agents for patients, and the managed care organization can credible commit to a level of utilization management is it optimal for the managed care organization to bear all of the risk. If either the managed care organization cannot commit to a level of utilization management or providers are not perfect agents for patients some degree of cost sharing between managed care organization and the payer is optimal. These results for cost sharing contracts between managed care organizations and payers extend Ellis and McGuire's (1986) analysis of prospective payment of providers.

---

[1] 2001 Sheridan Road, Evanston, IL 60208, (847) 491-8676, r-lindrooth@northwestern.edu. Key Words: health insurance, utilization management, capitation. JEL Classification: I1. This research was supported in part by the National Institute of Mental Health Grant R01-MH46522-03 and the Research Triangle Institute. The author would like to thank Ithai Lurie, Tom McGuire, participants in the CHAS/Health Economics Workshop, Triangle Health Economics Workshop and the Industrial Organization Brownbag Seminar at University of Washington for helpful comments.

Utilization Management and Cost Sharing between Payers and Insurers of Health Care

Abstract

The tradeoff between the amount of risk held by a managed care organization and utilization management is often over-looked in discussions about managed care. A payer of health insurance can induce the managed care organization to engage in the desired degree of utilization management through cost sharing. Only when the payer of health insurance is the government, providers are perfect agents for patients, and the managed care organization can credible commit to a level of utilization management is it optimal for the managed care organization to bear all of the risk. If either the managed care organization cannot commit to a level of utilization management or providers are not perfect agents for patients some degree of cost sharing between managed care organization and the payer is optimal. These results for cost sharing contracts between managed care organizations and payers extend Ellis and McGuire's (1986) analysis of prospective payment of providers.

Introduction

Utilization management in health care is ubiquitous. It is practiced to some extent by virtually every health insurer. Utilization management is a response to the inefficiencies caused by the fact that the health status of patients is imperfectly observable. While some effort towards utilization management may be preferred, too much effort may lead to undesirable health outcomes. The challenge facing policy makers, health care providers, patients, and payers of health insurance is to find payment schemes that take into account the competing objectives of cost and quality and to provide an incentive to engage in the proper amount of utilization management.

Traditionally, risk was shifted from health insurers to large purchasers of health insurance (e.g. firms) through experience rating (Newhouse, 1996). The risk to the insurer was that they would not be able to renew their contract with an employer and thus be unable to recoup current losses in the next year. Thus, there were no incentives to engage in utilization management. There were also no incentives given to providers to consider cost when making treatment decisions because payment of providers under the traditional system was fixed per unit of service.

In contrast, contracts taken on by managed care organizations usually provide strong financial incentives to control costs. Often the payment is per beneficiary (i.e. capitated) with limited risk-adjustment in following years. Thus, managed care organizations have an incentive to monitor the care of their beneficiaries through utilization management. In this paper we study contracts that are common in managed care arrangements called carve-outs.

A carve-out is a type of managed care contract where the treatment for a particular type of illness is handled under a separate contract. Mental health carve-outs are most common, but cancer care is also often carved-out. A firm may offer employees a menu of managed care plans, but the carved out benefit is often handled separately by a single plan. Carve-outs are also used by state Medicaid agencies to provide mental health care for Medicaid beneficiaries. For example, the Commonwealth of Massachusetts used this type of contract when the state contracted with a managed care organization to manage only the mental health care of Medicaid enrollees in 1993.

Usually Medicaid mental health carve-outs have cost sharing provisions between the managed care organization and the state agency to weaken incentives to reduce direct service expenditures. The specific terms of contracts used by state Medicaid agencies vary by state. In Massachusetts cost sharing bands ranged from 8%-20% depending on the year. In Iowa, for example, the contract included cost sharing bands of 20% with no caps. In Colorado, only stop-loss provisions are used. The contract for a carve-out in Nebraska is fully-capitated and thus no cost sharing or caps are used (Frank *et. al.* (1997).

In this paper we introduce a framework that allows for utilization management and focuses on the relationship between the payers of health insurance, the managed care organization, and providers. We model the relationship between the payer of health insurance and the managed care organization as a principal-agent game. The major implication is that financial incentives to the managed care organization can be adjusted to yield the desired patient health benefit. The cost to the payer of health insurance is more risk which in the long-run may be easier and less expensive than trying to monitor or regulate the relationship between managed care organizations and physicians.

Adverse selection is not an issue in the model presented below because enrollees are usually not given the option of opting out of carve-outs. Utilization management is incorporated into the model as effort by the managed care organization. The managed care organization devotes costly effort towards utilization management in order to change the treatment intensity of providers. Providers are paid a negotiated per unit of service under managed care. The optimal degree of cost sharing is an extension of Ellis and McGuire (1986). Ellis and McGuire examined prospective payment of providers, the model below shows that intuition of their model over to the case where managed care organizations are capitated and providers are paid a negotiated fee per unit of service and monitored.

The degree of utilization management is related to the provider's current treatment intensity. This aspect of the model is similar to the 'managedness' of providers discussed in Conrad and colleagues (1994) who document that a provider with experience with managed care are more desirable to the managed care organization due to lower monitoring costs. In addition, there may be less costly methods of inducing providers to change the way they provide care. Ma and McGuire (2002) introduce a theory of network incentives such that the threat of dropping a provider from the network may be sufficient to induce providers to give the desired level of care. Given their results, it may be possible to attain the first-best through proper incentives to managed care organizations.

The Model

The model is a two-stage game. The first stage is a variant of a principal-agent game where the principal is the payer of health insurance and the managed care organization is the agent. The model is different than the standard principal-agent model because the effect of effort by the managed care organization is not monotonic in the principal's objective function. Thus, even though both parties are risk-neutral, the problem does not reduce to a corner solution where the agent bears all of the risk. The contract between the principal and the managed care organization is the outcome of the first stage.

The second stage is a bargaining game between the managed care organization and a health care provider.[1] We assume that the managed care organization contracts with one provider in each market. After the contract with the principal is settled, the managed care organization negotiates with a health care provider. At this point only the distribution of illness is known. The outcome of the negotiation is the rate the health care providers are reimbursed. When a beneficiary becomes ill and seeks care only the health care provider and the managed care organization (through utilization management) are able to observe the true severity of illness. Neither the principal nor the patient can observe the true severity of illness. The timeline is shown in Figure 2.1:

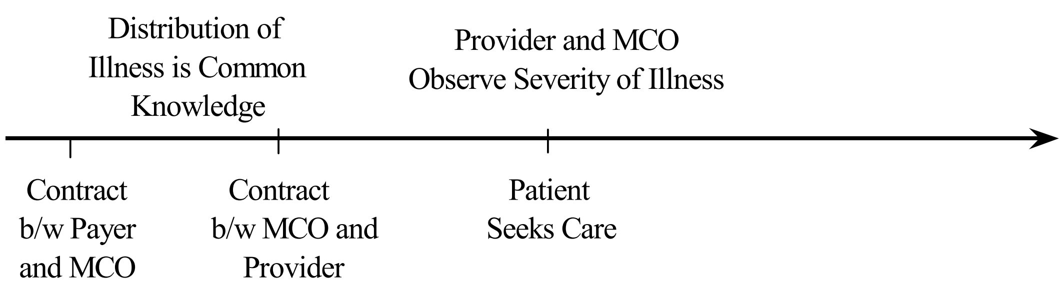

Figure 1. Timeline of the Model

Treatment intensity with utilization management

The principal (i.e. the payer) can observe the treatment intensity (e.g., length of stay) but does not know whether the treatment intensity was appropriate. The principal can observe neither the true underlying severity of illness of the patient nor the effort devoted to utilization management. The treatment intensity under utilization management, $\bar{I}$, is a function of the health care provider's treatment style, I; a random component reflecting severity of illness, ω; and the reduction in treatment intensity due to utilization management at provider, ξ; or

[1] We model a one-to-one bargaining game for simplicity so that we can focus on the implications of cost sharing between payers and managed care organizations. We address how this assumption affects the results below.

$$\bar{I} = I + \omega - \xi \ . \quad (1)$$

$\bar{I}$ represents the aggregate treatment intensity of a risk pool rather than individual realizations for each patient. In other words, it is a cumulative measure of the health services received by the entire risk-pool of patients treated at the provider.

This situation fits the principal-agent model because while the payer can observe $\bar{I}$, it cannot observe ω or ξ. Thus the objective of payer is to provide the managed care organization some incentive to put forth the desired ξ. The mechanism by which the payer influences the managed care organization is cost sharing. Cost sharing allows the managed care organization to share in the benefits of exerting ξ and in doing so gives them incentive to exert an optimal level of effort.

The Bargaining Stage

In the second stage, the managed care organization and the health care provider bargain over the rate. The bargaining process is very simple; yet it reflects the actual contracts that are negotiated (See Fisher *et al.*, 1998). The profit of the managed care organization is the revenue from capitated payments from the principal less the cost of treating the patient and the cost of utilization management (See Equation 2 below). The health care provider's utility is the negotiated rate less the service cost of treating the patient multiplied by the treatment intensity. In addition, we assume a degree of agency between the health care provider and the patient so that the health care provider's utility is affected by the appropriateness of care given to the patient. The managed care organization's profit from an agreement with the health care provider is

$$M = (1-\psi)(r - p\bar{I}) - g(\xi) \quad (2)$$

and the health care provider's utility is

$$H = (p - c)\bar{I} + \gamma F(\bar{I}) \quad (3)$$

where

ψ =the cost sharing parameter,

r = the capitated (per patient) rate the principal pays to the managed care organization,

$g(\cdot)$ =a function that describes the cost of utilization management,

p =the rate negotiated by health care provider and the managed care organization,

γ = the degree of agency between the patients and the health care provider,

$F(\bar{I})$ =the health benefit of a risk pool of patients with utilization management,

c =the marginal cost of $\bar{I}$,

$g'(\cdot) \geq 0$, $g'(0) = 0$, $g''(\cdot) \geq 0$, $F'(\cdot) > 0$, $F'(0) = \infty$, and $F''(\cdot) \leq 0$.

The aggregate size of the joint surplus of an agreement depends on health care provider's current treatment intensity. The joint surplus is the benefit to both parties that is a result of an agreement. The maximum joint surplus is attained when the health care provider's current treatment is identical to the managed care organization's desired treatment intensity and no costly utilization management is necessary. However, this outcome is not attainable without managed care because under cost-based reimbursement (i.e. *p*=*c*), health care providers are not held financially responsible for treatment intensity and the providers will choose treatment intensity such that the marginal benefit to the patient is zero.

Equilibrium in the bargaining model

Asymmetry in the bargaining power of the managed care organization and provider is incorporated in the model by weighting the share of the surplus by α and $(1-\alpha)$. The larger α, the stronger the managed care organization will be relative to the health care provider. As described in Binmore, Rubinstein, and Wolinsky (1986), the Perfect Nash equilibrium is characterized by the solution to the maximization problem,

$$\underset{p}{Max}\ S = M^{\alpha} H^{(1-\alpha)} \tag{4}$$

Without loss generality we assume the status quo outcome is zero[2]. Solving the first order condition of Equation 4 for equilibrium price yields (see Appendix for a derivation of this result and the second order condition):

$$p^{*} = \frac{\frac{(1-\alpha)}{(1-\psi)}\left[(1-\psi)r - g(\xi)\right] + \alpha c\bar{I} - \alpha\gamma F\left(\bar{I}\right)}{\bar{I}} \tag{5}$$

In contrast to the rate, treatment intensity is not an outcome of the bargaining game. The intensity of utilization management, ξ, depends on the difference between the health care provider's current treatment intensity, I, and the desired treatment intensity, $\bar{I}$. We examine optimal treatment intensity under two alternative situations below: one where the managed care organization can commit to ξ when p is negotiated and one where it cannot.

Choice of effort (ξ_i) when Managed Care Organization can Commit

Given the Nash outcome in the second stage, the managed care organization's expected profit, conditional an agreement with health care provider *i,* is:

$$M = (1-\psi)\left(r - p^{*}\bar{I}\right) - g(\xi). \tag{6}$$

The managed care organization will choose effort to maximize their profit. The first-order condition is:

---

[2] In a earlier version of this paper we modeled the status quo outcome as the price and intensity without managed care, the results were identical to the one that we present below.

$$\frac{\partial M}{\partial \xi} = (1-\psi)\left(p^* - \frac{\partial p^*}{\partial \xi}\bar{I} \right) - g'(\xi) = 0 \qquad (7)$$

Calculating $\frac{\partial p^*}{\partial \xi}$ from Equation 5 and simplifying Equation 7 yields (see Appendix for the derivation of this result and the second order condition):

$$g'(\xi) = (1-\psi)\left(c - \gamma F'(\bar{I})\right) \qquad (8)$$

Thus the managed care organization chooses a level of effort such that the marginal cost of utilization management equals net marginal benefit. The right-hand side of this equation is strictly greater than zero for $\psi < 1$. If $\psi = 1$, the managed care organization would have no incentive to engage in utilization management and $g'(0) = 0$. The term on the right-hand side of Equation 8 reveals that changes in treatment intensity affect profits of the managed care organization by changing the size of the pie. It is in the managed care organization's best interest to maximize the joint surplus—conditional on the bargaining outcome. Thus there are two costs of utilization management: the direct cost, $g(\cdot)$ and an indirect cost due to bargaining, $\gamma F(\bar{I})$. Utilization management is more costly when the health care provider's objective function is a function of the health outcome.

Choice of effort (ξ_i *) when Managed Care Organization cannot Commit*

Here the price is fixed when the managed care organization selects ξ. Therefore, the first order condition will be:

$$g'(\xi) = (1-\psi)(P^*) \qquad (8')$$

Medicaid as the payer of health insurance[3]

Medicaid's expected optimal payment function can be written as:

$$Y = r + \psi\left(p^{*}\,\bar{I} - r\right). \qquad (9)$$

Medicaid chooses an optimal cost sharing parameter, desired effort and a capitated rate to maximize welfare defined as the benefit to the patient of treatment, less the cost of treatment to Medicaid (Equation 9), plus the utility of the health care provider and managed care profits:

$$W = F\left(\bar{I}\right) - Y + \left(p \;\; - c\right)\bar{I} + \gamma F\left(\bar{I}\right) + \left(1-\psi\right)\left(r - p\;\bar{I}\right) - g(\xi\;). \qquad (10)$$

This is equivalent to maximizing social welfare. Equation 10 is maximized subject to the managed care incentive compatability constraint (Equation 8); the outcome of the second stage, $p = p^{*}$; and the managed care organization's participation constraint, $M \geq 0$. As shown in the appendix, solving the first-order conditions and simplifying yields the following expression:

$$\left(1 + \gamma\right)F'\left(\bar{I}^{*}\right) + g'\left(\xi^{*}\right) = c \qquad (11)$$

Optimal effort is chosen to satisfy Equation 11, note that effort is a function only of the cost of care, the shape of *g* and *F*, and the parameter γ. The cost sharing parameter (ψ) is chosen to satisfy the incentive compatibility constraint (Equation 8) and *r* is chosen to satisfy the participation constraint (M=0). If the managed care organization cannot commit to a level of effort then ψ and ξ are chosen to satisfy Equation 11 and the incentive compatibility constraint in Equation 8' rather than Equation 8.

The first-best outcome is attained only when $\xi^{*}=0$ and the marginal benefit of care is equal to the marginal cost. Equation 11 implies that treatment intensity with managed care and

[3] If the payer is a firm the objective function becomes: $W = F\left(\bar{I}\right) - \left(1-\psi\right)r - \psi p\;\bar{I}$. We were unable to derive the optimal effort if firms are the payer without making the unrealistic assumption that *p* is exogenous.

cost sharing between Medicaid and managed care is higher than the optimal treatment intensity, but lower than what would be attained without managed care (See Proposition 4 below).

Results

Proposition 1. It is never optimal for the managed care organization to bear all of the risk ($\psi > 0$), regardless of whether or not the managed care organization can commit to treatment intensity.

Proof: Solving Equation 8 for ψ and substituting for $g'(\xi^*)$ using Equation 11 yields: $\psi^* = \frac{F'(\overline{I^*})}{c - \gamma F'(\overline{I^*})}$. $F'(\bar{I}^*)$ cannot equal zero unless $\overline{I^*} = \infty$, which is not possible in this model because it is not possible to expend negative effort ($\xi < 0$). Proposition 1 is partially due to the fact that provider utility is included in the Medicaid objective function. Thus the health benefit to the patient is weighted directly through patient welfare and indirectly through the provider's utility.

This results carries over to the case where the managed care organization cannot commit to a level of utilization management. Solving Equation 8 for ψ and substituting for $g'(\xi^*)$ using Equation 11 yields: $\psi^* = 1 - \frac{c - (1+\gamma)F'(\bar{I}^*)}{P^*}$. ψ *=0 only if $P^* = c - (1+\gamma)F'(\overline{I^*})$.

However $P^* > c - (1+\gamma)F'(\bar{I})$ because if a provider were to choose there own treatment intensity (conditional on price), they would choose: $P^* = c - \gamma F'(\overline{I_p^*})$, where $\overline{I_p^*}$ is the choice of treatment intensity the maximizes providers utility conditional on price. However $\bar{I}^* < \overline{I_p^*}$ since ξ^*>0 and $F''(\cdot) \leq 0$ it follows directly that $P^* > c - (1+\gamma)F'(\bar{I}^*)$. This result is true for any negotiated price, whether it a result of one-to-one bargaining or many-to-one bargaining.

An alternative specification of the objective function such that only provider profits are included yields *Proposition* 2. In this specification the patient benefit is not double counted.

Proposition 2. If Medicaid's objective function is the sum of patient benefit, provider profits and Medicaid expenditures then the managed care organization should bear all of the risk only when the provider is a perfect agent for the patient ($\gamma = 1$) and the managed care organization can commit.

Proof: First note that in this case Medicaid's objective function is:

$W = F(\bar{I}) - Y + (p \;\; - c)\bar{I} + (1-\psi)(r - p \;\; \bar{I}) - g(\xi \;\;)$. Thus Equation 11 becomes $F'(\bar{I}^*) + g'(\xi^*) = c$.

Solving Equation 8 for ψ and simplifying yields: $\psi^* = 1 - \dfrac{c - F'(\bar{I}^*)}{c - \gamma F'(\bar{I}^*)}$. Thus when $\gamma = 1$, the managed care organization will bear all of the risk.

If health care providers value patient outcomes then there are two costs of utilization management. First there is the direct cost to the managed care organization, $g(\bar{I})$. Second, as treatment intensity falls, the patient benefit will also be lower, so the total surplus of the agreement between the managed care organization and the health care provider will be lower relative to the case when the provider does not value the health come of the patient. Note that this result is similar to Ellis and McGuire's (1986) sharing rule which, when rewritten in our notation, is $\gamma \mathrm{F}'(\bar{\mathrm{I}}) = (1-\psi) * c$. Ellis and McGuire looked at prospective payment of physicians in their model. Similar to the model presented here, physicians trade off financial reimbursement for quality. The difference is that there is a direct trade-off in the Ellis and McGuire model because physicians are paid prospectively. Here the tradeoff is such that the managed care organization will lessen treatment intensity when providers value patient outcomes. As in Ellis and McGuire's model, providers sacrifice financial outcomes for patient outcomes.

Proposition 3*. *If Medicaid's objective function is the sum of patient benefit, provider profits and Medicaid expenditures and the managed care organization cannot commit to* ξ_i *then the managed care organization should never bear all of the risk.

Proof: As in *Proposition 2* , Equation 11 becomes: $F'\left(\overline{I}^*\right) + g'\left(\xi^*\right) = c$. Solving Equation 8' for ψ and substituting for $g'\left(\xi^*\right)$ yields: $\psi^* = 1 - \frac{c - F'\left(\overline{I}^*\right)}{P_i^*}$. The proof follows from the proof of Proposition 1. This result is true for any negotiated price, whether it a result of one-to-one bargaining or many-to-one bargaining.

Proposition 4. The equilibrium level of treatment intensity with utilization management is the second-best outcome and the level of treatment intensity without utilization management is the third best.

Proof: This is equivalent to establishing that some cost sharing between a payer and the managed care organization is optimal. First note that Medicaid is maximizing social welfare when it considers provider's utility. Assume that it is optimal for the managed care organization to not engage in utilization management. The first order conditions imply that this will only occur when there is no cost sharing and the marginal benefit of care to society is equal to the marginal cost. However, providers will choose $\overline{I_p^*}$ using the following rule

$P^* = c - (1+\gamma)F'\left(\bar{I}_p^*\right)$ if ξ^*=0. The providers will choose the optimal $\overline{I_p^*}$ only if $P^* = 0$.

P^*=0 is not a possible outcome of the bargaining game.

Proposition 5. Effort devoted to utilization management will decrease as costs fall ($\partial\xi^*/\partial c > 0$ ***) and as the degree provider's value health outcomes increases (*** $\partial\xi^*/\partial\gamma < 0$ ***).***

Proof: From Equation 11: $\partial\xi^*/\partial c = \dfrac{1}{g''-(1+\gamma)F''} > 0$ since $g''(\cdot) \geq 0$ and $F''(\cdot) \leq 0$.

$\partial\xi^*/\partial\gamma = \dfrac{-F'}{g''-(1+\gamma)F''} < 0$ since $F'(\cdot) > 0$.

The marginal benefit of utilization management is lower at providers with lower marginal costs. Thus, less effort is devoted towards utilization management at these hospitals. In addition, the extent that the provider values health outcomes imposes a secondary cost of utilization management and thus lowers equilibrium effort. These results do not depend on the assumption of one-to-one bargaining.

Proposition 6. Effort towards utilization management will increase as I increases ($\partial\xi^*/\partial I > 0$ ***). Furthermore, equilibrium treatment intensity will increase as I increases (*** $\partial\bar{I}^*/\partial I > 0$ ***).***

Proof: From Equation 11: $\partial\xi^*/\partial I = \dfrac{-(1+\gamma)F''}{g''-(1+\gamma)F''} > 0$ since $g''(\cdot) \geq 0$ and $F''(\cdot) \leq 0$.

Furthermore, from Equation 1: $\partial\bar{I}^*/\partial I = 1 - \partial\xi^*/\partial I$. $\partial\xi^*/\partial I < 1$ because $g''(\cdot) \geq 0$ and therefore $\partial\bar{I}^*/\partial I > 0$. These results do not depend on the assumption of one-to-one bargaining.

Health care providers that already are already efficient will need less monitoring and therefore will be more attractive to the managed care organization. Part of the motivation for contracting with efficient health care providers lies in the fact that monitoring health care providers using utilization management is costly and they reimburse providers per unit of treatment intensity.

Discussion

The model implies that some degree cost sharing is optimal in contracts with managed care organizations. Note that this result applies to the case when managed care organizations use monitoring rather than incentives to solve the agency problem with providers. Only in a special case, when providers are perfect agents for the patients and managed care organizations can commit to treatment intensity, is it optimal for the managed care organization to be fully capitated. This result is consistent with Ellis and McGuire's (1986) analysis of prospective payment of providers. In fact, one major implication that carries over from Ellis and McGuire's analysis to managed care with utilization management is that effort devoted towards utilization management falls (or quality increases in Ellis and McGuire) as the degree providers value health outcomes increases. In the model presented here, both the providers and the payers of health insurance represent the patient's interest in counteracting the incentives of the managed care organization.

However, in a one-shot game it is probably unlikely that a managed care organization will be able to credibly commit to treatment intensity when price is negotiated. It would only be credible if the intensity of utilization depended upon the size of the infrastructure set up to monitor providers, which is probably not realistic in the case of health care. However, because contracts are generally renegotiated annually, the managed care organization may have a strong enough incentive to make commitment to a level utilization management credible. Even if commitment is not credible, we proved that the majority of qualitative results presented in this paper continue to hold. The main effect of an inability to commit is that payers will retain more of the cost (lower ψ).

The results suggest that some degree of cost sharing between payers and managed care organizations is generally desirable because too much risk held by a managed care organization may lead to overly aggressive utilization management. The recent backlash against managed care is largely due to concerns that utilization management is overly stringent and has lead to lower than desired treatment intensity. In this paper, we show that the problem lies not in the notion of managed care; instead they are a result of too much risk being held by the managed care organization.

Appendix

Derivation of Equation 5

a. Maximize Equation 4.

b. The first-order condition after simplification will be:

$$\frac{\partial S}{\partial p}: \quad -\alpha(1-\psi)H(\bar{I})+(1-\alpha)M(\bar{I})=0 \tag{A.1}$$

c. Substituting in *M* and *H* from Equations 2 and 3, respectively, and solving for *p* yields Equation 5.

d. The second-order condition after simplification will be:

$$\frac{\partial S^2}{\partial^2 p}: \quad -\alpha(1-\psi)(\bar{I}^2)+(1-\alpha)^2(\bar{I}^2)<0 \tag{A.2}$$

Thus the equilibrium price defined in Equation 5 is a maximum.

Derivation of Equation 8

a. Form Equation 5 note that

$$\frac{\partial p^*}{\partial \xi}=\frac{(1-\psi)(\alpha\gamma F'(\bar{I})-\alpha c)-(1-\alpha)g'(\xi)}{(1-\psi)\bar{I}}+\frac{p^*}{\bar{I}}$$

$$=\frac{(p^*+\alpha\gamma F'(\bar{I})-\alpha c)}{\bar{I}}-\frac{(1-\alpha)}{(1-\psi)\bar{I}}g'(\xi) \tag{A.3}$$

b. Substituting Equation A.3 into Equation 7 yields the first-order condition:

$$(1-\psi)(c-\gamma F'(\bar{I}))-g'(\xi)=0 \tag{A.4}$$

Equation 8 follows directly from Equation A.4.

c. The second-order condition is:

$$(1-\psi)\left(\gamma F''\left(\bar{I}\right)\right)-g''(\xi)<0 \qquad \text{(A.5)}$$

due to the shape of the health benefit and cost of effort functions.

Derivation of the Optimal Cost sharing Rule

Medicaid or Medicare chooses ψ and r to maximize Equation 10 subject to the managed care organization's incentive compatability constraint (Equation 8), and the participation constraint. Substitution of the participation constraint simplifies the maximization problem to:

$$\underset{\psi,\xi}{Max} \quad W=(1+\gamma)F\left(\bar{I}\right)-c\,\bar{I}-g(\xi) \qquad \text{(A.6)}$$

subject to: $g'(\xi\ )=(1-\psi)\left(c-\gamma F'\left(\bar{I}\right)\right)$

The cost sharing parameter, ψ, does not enter Medicaid's objective function. Thus ξ^* can be derived from the first order conditions of an unconstrained optimization of W. Then ψ* is the level that induces ξ^* according to the incentive-compatibility constraint: $g'(\xi^*\ )=(1-\psi^*)\left(c-\gamma F'\left(\bar{I}\right)\right)$. The first order condition of an unconstrained maximization of W is:

$$\partial W/\partial\xi:\ -(1+\gamma)F'\left(\bar{I}\right)+c-g'(\xi)=0 \qquad \text{(A.7)}$$

c. The second order condition is:

$$|H|=\left((1+\gamma)F''\left(\bar{I}\right)-g''(\xi)\right)<0 \qquad \text{(A.8)}$$

References

Binmore, K., A. Rubinstein, and A. Wolinsky, 1986, The Nash bargaining solution in economic modeling, *Rand Journal of Economics* 17, 176-188.

Conrad, D., T. Wickizer, C. Maynard, T. Klastorin, D. Lessler, A. Ross, N. Soderstrom, S. Sullivan, J. Alexander, and K. Travis, 1996, Managing care, incentives, and information: An exploratory look into the black box of hospital efficiency, *Health Services Research*, 31, 235-259.

Ellis, R.P. and T.G. McGuire, 1986, Provider behavior under prospective reimbursement: Cost sharing and supply, *Journal of Health Economics* 5, 129-151.

Fisher, B., R.C. Lindrooth, E.C. Norton and B. Dickey, 1997, How managed care organizations develop selective contracting networks: A case study from Massachusetts, *Inquiry,* Winter 1998/1999.

Frank, R.G., T.G. McGuire, E.H. Notman, and R.M. Woodward, 1997, Developments in Medicaid managed behavioral health care, Mimeo.

Ma, C. A., and T.G. McGuire, 2002, Network incentives in managed care. Forthcoming in *Journal of Economic and Management Strategy.*

Newhouse, J. P, 1996, Reimbursing health plans and health providers: selection versus efficiency in production, *Journal of Economic Literature* 34, 1236-1263.