MITIGATING AGENCY PROBLEMS BY ADVERTISING, WITH SPECIAL
REFERENCE TO MANAGED HEALTH CARE

Paul H. Rubin and Joel L. Schrag

December 9, 1998

Abstract: An agency conflict arises when consumers rely on middlemen for product recommendations. While consumers want the middlemen to recommend the most suitable product, the middlemen may earn a higher profit if the consumer buys some other product. An important setting where this conflict arises is the managed health care market. Managed health care providers have an incentive to spend too little on prescription drugs. We investigate whether pharmaceutical manufacturers can use advertising to mitigate this agency conflict. We find that advertising may induce health care providers to offer socially efficient medications, though drug companies may not choose the socially efficient level of advertising. It will also pay for drug companies to inform consumers if they will not benefit from some drug, as this will increase the price that those who will benefit will be willing to pay.

JEL Codes: L15, L13, I11

* Assistant and Full Professor of Economics, Emory University, Atlanta, GA 30322-2240. Rubin can be reached by e-mail at prubin@emory.edu and by phone at (404) 727-6365. Schrag can be reached at jschrag@emory.edu and by phone at (404) 727-6363. Both authors can be reached by fax at (404) 727-4639. This research was supported by a grant from Pfizer, Inc. The authors retain all editorial control over this research. We thank Jonathan Hamilton and two anonymous referees for helpful comments. All errors remain the responsibility of the authors.
1. Introduction

Manufacturers often sell their products to middlemen, who in turn resell the manufacturers’ goods to consumers. Middlemen may serve as the agents of the manufacturers, the consumers, or possibly both of these groups. When they are agents of the manufacturers, middlemen typically promote, sell, and service the manufacturers’ products. When they are agents of the consumers, middlemen supply product-related information and help consumers decide which product to buy.

In this paper we study the conflict that arises in the agency relationship between consumers and middlemen. The source of the agency problem that we study lies in the information asymmetry between consumers (the principals) and middlemen (the agents). Our formal assumption is that consumers do not initially possess the information that they need in order to choose the best or most suitable products. Therefore, they must rely on their agents, the middlemen, for recommendations. But the middlemen wish to maximize their own profits, and this goal may conflict with their obligation to recommend the product that is optimal for consumers. If a conflict exists, the middlemen may try to influence consumers to use the most profitable product, rather than the product that the consumers would prefer.

The parties involved in an agency relationship often find it profitable to take actions that mitigate the effect of the conflict of interests that inheres in their relationship. For example, the standard literature on agency relationships investigates whether the parties can design a contract that reduces the effect of the information asymmetry between the parties.\footnote{See, e.g., Maggi and Rodriguez-Clare (1995), who study an agency relationship in which the agent can falsify information that he transmits to the principal.} We consider an alternative solution to the agency conflict between consumers and middlemen by asking whether a third party, namely a product manufacturer, can take an action that mitigates their agency conflict. In particular, we analyze whether informative advertising by a manufacturer will enable consumers and middlemen to overcome their conflict of interests. Though it has not been studied from this perspective, much manufacturer advertising to consumers might be aimed at solving agency problems. For example, a manufacturer’s price advertising may eliminate the retailer’s ability to...
charge a price that is higher than the manufacturer desires. A manufacturer may also be able to induce distributors to carry its entire product line by advertising the existence of the full range of products that it produces.

While the agency problem that we address arises in many different contexts, in this paper we study the particularly important conflict over the prescription of pharmaceuticals that arises between consumers and providers of managed health care. Health maintenance organizations (HMOs) and other providers of managed health care typically charge consumers an essentially fixed price and in return supply virtually all of their medical care, including prescription drugs. Managed health care curbs an agency problem that exists in traditional fee-for-service medical insurance markets, where physicians (who are the agents for the patients) have a strong incentive to provide too much care. Unfortunately, the advent of managed health care has created a different agency problem, because health care providers now have an incentive to provide too little care, including prescription drugs. This agency problem stems from the information asymmetries that exist between a patient (the principal) and a health care provider (the patient’s agent). While a patient is aware of (at least some of) his symptoms, he typically relies on the physician to diagnose his condition. Furthermore, a physician is usually better informed than the client about the therapies that are available to treat the patient’s condition. These information asymmetries create the possibility for moral hazard in a managed care environment; health care providers have an incentive to choose the cheapest therapy, not necessarily the most effective or even the most cost-effective therapy. Furthermore, the patient’s lack of knowledge limits his ability to monitor the physician’s decisions.

This moral hazard problem affects patients’ access to pharmaceuticals. Because HMOs bear the lion’s share of the cost of prescription drugs but receive only a fraction of the benefit, they do not have the correct incentive to provide the drugs that are optimal from the consumer’s point of view. Instead, they may seek to minimize their expenditures on pharmaceuticals. In 1996, 24.4 percent of HMOs offered financial incentives to

---


3 Our paper is related to the literature on credence goods, such as Emons (1997), which studies markets in which consumers rely on experts for services. Emons shows that, in markets where capacity constraints
physicians to encourage them to reduce the cost of medication. (Hoechst Marion Roussel, 1996. See also Johannes, 1997.) Furthermore, some managed health providers attempt to conceal information about the drugs that are available, even forbidding their member physicians from telling consumers about therapies that are not available to members of the HMO. Faced with the difficulty of acquiring independent information about pharmaceuticals, it is doubtful that individual consumers could by themselves effectively overcome this moral hazard problem.

In this paper we investigate whether drug manufacturers can use advertising to provide consumers with the information that they need to overcome this agency problem. We analyze this issue in a model in which consumers choose to purchase their health care from one of two HMOs. Each HMO offers medical care that includes a differentiated composite medical good and at least one prescription drug. We assume that different prescription drugs offer different benefits. Consumers may not initially possess the information that would enable them to identify the prescription drug that would be best for them, but we suppose that a drug’s manufacturer can use advertising to inform consumers about the benefit that they would receive from the drug.

We analyze our model under the assumption that consumers are initially uninformed about the benefits that they receive from different drugs. In this case, price competition alone cannot guarantee that the consumers will receive the socially optimal drug. Intuitively, if consumers do not recognize the benefits that they receive from different prescription drugs, the HMOs have an incentive to offer the cheapest drugs, rather than the drugs that yield the largest net benefit. Nevertheless, we show that advertising by a manufacturer may induce the HMOs to offer a drug, potentially improving social welfare. Intuitively, consumers who learn about an effective drug through advertising will be drawn to HMOs that make the drug available, encouraging HMOs to compete by offering the drug.

While advertising may mitigate conflicts of interest between HMOs and consumers, we show that a drug manufacturer will not necessarily choose the socially efficient level of advertising. This result stems from the multiple equilibria that arise in the model. When a
drug’s manufacturer chooses the socially efficient level of advertising there are several equilibria, including one in which the HMOs adopt the drug for sure and another in which they choose not to adopt the drug. The manufacturer’s incentive to advertise depends on which equilibrium the HMOs play.

We also point out that the manufacturer of a socially efficient drug may be able to choose from two alternative strategies that would induce the HMOs to offer its drug. First, if the manufacturer’s unit costs are lower than its competitors’ costs, it can simply undercut their prices. Because the HMOs always prefer to offer the cheapest possible drug, advertising would then not be needed to induce the HMOs to offer the socially efficient drug. Alternatively, the manufacturer could choose to set a price that is above its competitors’ prices and rely on advertising to stimulate demand. This strategy may be more profitable for the manufacturer than undercutting its competitors’ prices. While static welfare is enhanced if the producer of the socially efficient drug undercut the prices of drugs that generate less surplus, this may not be the most profitable strategy for the manufacturer.

The preceding observation leads to the conclusion that the welfare effects of a fall in the price of advertising will in general be ambiguous. Cheaper advertising may encourage manufacturers to provide more information to consumers, which would tend to improve welfare. On the other hand, a fall in the price of advertising may lead the producer of the socially efficient drug to stop undercutting its rivals’ prices and instead rely on advertising to generate demand for its drug. In our model, this change in strategy reduces the number of people who receive the socially efficient drug, harming welfare.

Clearly, a fall in the price of advertising would harm static welfare if it led to a decline in the number of people using socially efficient drugs. Nevertheless, dynamic welfare could still be enhanced, because the expected profits from producing pharmaceuticals would increase. Because higher expected profits encourage investment in research and development projects, a fall in the price of advertising should, over time, increase the rate at which new drugs are discovered. This effect clearly improves welfare.⁴

---

⁴ We plan to examine this issue in future research.
Finally, we analyze the effect of advertising that helps consumers who are already aware of the existence of a drug to better estimate the net benefit that they receive from consuming it. We find that there are circumstances in which it is beneficial for the drug’s manufacturer to share such information with consumers, even when doing so reduces the number of consumers who receive the drug. Such advertising may enable the drug’s manufacturer to charge a higher price for its product, and the firm’s revenue may therefore fall by less than its costs, increasing profits. Such advertising may even enable a manufacturer to produce a product that otherwise would not be profitable. We conclude that drug manufacturers do not in general benefit from selling their products to consumers who do not need them.

Our analysis hinges on the assumption that consumers are able to use the information in drug manufacturers’ advertisements both to better assess the value of different prescription drugs and to influence their doctors’ prescribing behavior. This sort of advertising can make information regarding prescription drugs that would otherwise be private to the agent (the physician or the HMO) public to the principal (the patient). The patient can then request these medications from the physician, or evaluate the health plan’s formulary (the list of the health plan’s approved medications) to determine whether it contains the drug of interest.\(^5\) If the particular medications are not available or are not included in the health plan formulary, this information is valuable to the patient.

While direct evidence on the effect of drug manufacturers’ advertising to consumers is difficult to find, the firms themselves clearly believe it is valuable. Drug advertising increased ten-fold from 1991 to 1996, rising to $600 million. (Zuger, 1997) It reached $631 for the first six months of 1998, due in part to the decision by the Food and Drug Association (FDA) to loosen regulations on television advertising by pharmaceutical manufacturers (IMS, 1998a.) According to a survey reported by the American Medical Association, in 1995 fifty-one percent of physicians reported that patients asked about drugs they had seen advertised, compared to only twenty-one percent in 1989.

\(^5\) Eighty-one percent of HMOs rely on formularies, or lists of approved medications, in order to control their drug expenses. (Hoechst Marion Roussel, 1996) Formularies may be either restrictive, permitting doctors to prescribe only the drugs included in the formulary, or non-restrictive, providing only guidelines for doctors’ prescriptions. According to Kreling and Mucha (1992), most restrictive formularies permit
Furthermore, ninety-nine percent of physicians surveyed said that they would consider prescribing a drug requested by a patient.\textsuperscript{6} The trend continues upward: for 1998, 48% of pharmacy directors of HMOs indicated an increase in patient requests for off-formulary approval, largely as a result of advertising (IMS, 1998b).

It is important to distinguish the moral hazard problem that we study from the issue that is addressed in the literature on the reputational enforcement of quality promises. In this literature, either a producer (as in Klein and Leffler (1981) and Shapiro (1983)) or a middleman (as in Biglaiser (1993) and Biglaiser and Friedman (1994)) promises to supply a high quality product to the consumer. This promise is credible because, by cheating, the producer or the middleman would lose his or her valuable reputation as a trustworthy supplier. A crucial assumption in these papers is that, ex post, a consumer can identify the quality of the good that he receives and, therefore, can verify whether the supplier did in fact live up to its promise. The consumer must have this information in order to retaliate against a supplier who cheats. It is the threat of this retaliation that gives the producer the incentive to provide a high quality good.

In the health care setting, consumers may not have the information that they need to assess whether their providers fulfill their promises. A managed health provider would like to credibly promise to make the most cost-effective medicines available because this would increase the value of its health plan to consumers. However, if consumers are not informed about what medications are available, a health care provider cannot make such a promise credibly. Intuitively, if consumers are unable to verify whether the health care provider fulfilled its promise to provide the most cost-effective medicines, they cannot retaliate against the provider if it cheats. But if there is no threat of retaliation, the provider has no incentive to fulfill its promises.

There is a potential gain to both parties if consumers obtain the information that they need in order to verify whether health care providers fulfill their promises. In the next two sections we develop a formal model that shows how advertising by pharmaceutical manufacturers can make this possible. This benefit of consumer advertising is in addition

\textsuperscript{6} American Medical News, February 10, 1997, at http://www.ama-assn.org/sci-
to other benefits already identified in the literature (e.g., Masson and Rubin, 1985; Rubin, 1991).

2. Model

Two health maintenance organizations (HMOs) offer health care to consumers. Each HMO provides two forms of health care: a composite medical good and prescription drugs. A consumer may prefer the HMO that offers care at the closest location, or he may wish to join an HMO that employs a particular physician. We therefore assume that the two HMOs’ composite medical goods are imperfect substitutes. In order to model these preferences, we adopt a Hotelling-style model of differentiated products, in which consumers are uniformly distributed on the unit interval according to the density function $f(x) = 1$, $x \in [0,1]$. We normalize the number of consumers to be exactly one. HMO 1 is located at the left-hand endpoint of the unit interval, and HMO 2 is located at the right-hand endpoint. See Figure 1.

![INSERT FIGURE 1 ABOUT HERE]

A consumer’s utility from consuming HMO $i$’s services depends on HMO $i$’s price $p_i$ and the distance $d_i$ from the consumer’s location to HMO $i$’s location, $i \in \{1, 2\}$. The distance $d_i$ can be interpreted either as the consumer’s distance from HMO $i$’s physical location or as a measure of the difference between the mix of services that HMO $i$ offers and the consumer’s preferred mix of services. Formally, a consumer receives utility $u(d_i, p_i) = \alpha - td_i - p_i$ from consuming HMO $i$’s composite medical good. The parameter $t > 0$ represents either a unit transportation cost if the consumer must travel to the HMO’s location or a unit disutility cost that the consumer bears when unable to consume his preferred variety of the composite medical good.

Consumers also receive utility from consuming one of the available prescription drugs. For simplicity, we assume that the set of available drugs is $\Delta = \{A, B\}$. The marginal cost
of producing drug \( z \in \Delta \) is \( k_z \geq 0 \). We assume that drug A is no longer protected by a patent and therefore is produced competitively. We assume furthermore that a single firm, say Firm B, produces drug B under patent protection. While strong, these assumptions simplify the strategic interactions between manufacturers of different drugs. In the conclusion we comment on the robustness of our results to changes in these assumptions.

Different consumers may receive different benefits from the available drugs. For instance, consumers may suffer from side effects of varying intensity. We therefore assume that the benefit that an individual consumer receives from a drug depends on his type \( \theta_y \in \{ \theta_1, \theta_2 \} \). The probability that a consumer is type \( \theta_1 \) is \( \mu \in (0, 1] \). Define \( v^z_y \) as the benefit that a consumer of type \( \theta_y \) receives from drug \( z \in \{ A, B \} \). We assume that \( v^A_1 = v^A_2 = \bar{y}, v^B_1 = \bar{v}, v^B_2 = \bar{y}, \) and \( \bar{v} > \bar{y} \). Under these assumptions, consumers of type \( \theta_1 \) receive a higher benefit from drug B than from drug A, while consumers of type \( \theta_2 \) receive the same benefit from both drugs.

A consumer’s utility from consuming health care is the sum of his payoffs from the composite medical good and the prescription drug that he consumes. Thus, if a consumer of type \( \theta_y \in \{ \theta_1, \theta_2 \} \) contracts with HMO \( i \) for medical care at a price \( p_i \) and consumes prescription drug \( z \in \Delta \), his utility is \( u(d_i, p_i) + v^z_y = \alpha - td_i - p_i + v^z_y \). Consumers choose their HMOs in order to maximize their expected utility given what they know about their location, the different HMOs’ prices, and the prescription drugs that each HMO will provide. While we assume that consumers always observe their locations and the HMOs’ prices, we analyze the model under different assumptions about what consumers know about the prescription drugs that are available to them.

Risk-sharing between consumers and managed health providers is clearly an important aspect of the health insurance market that our model does not address. Our formal assumption is that consumers always benefit from consuming both the composite medical good and a unit of one of the two prescription drugs. Introducing risk into the model would needlessly complicate the analysis without shedding light on our main question, namely the effect of drug advertising on HMOs’ drug adoption decisions.
It is straightforward to establish that consumers always receive the optimal drug if they are completely informed about the benefits that each drug yields. But it is unlikely that consumers are always independently able to acquire such extensive information. We therefore analyze our model under the assumption that consumers are initially unaware of both their types and the benefits that different drugs yield. We consider the effect of advertising that provides this information to consumers.

A potential agency problem arises in the relationship between HMOs and their clients when consumers are unaware of the benefits that they receive from different prescription drugs. Ex ante, the optimal contract between a consumer (the principal in the relationship) and the HMO (the consumer’s agent) would direct the HMO to prescribe the prescription drug that yields the highest net benefit to the consumer. At the time the HMO chooses the consumer’s treatment, however, the HMO prefers to prescribe the cheapest possible drug. Indeed, the HMO may prefer to provide no treatment at all. If a consumer is uninformed about the benefits and costs of different drugs, he will be unable to monitor the HMO’s behavior, and the optimal contract will be unenforceable.

Although consumers are initially unaware of the benefits that they receive from different drugs, a drug’s manufacturer can use advertising to inform consumers about its product. The competitive producers of drug A would never choose to advertise. These firms must price at marginal cost and would therefore never recover the cost of advertising. The producer of drug B, however, may wish to advertise since it has a monopoly over the production of drug B and can choose a price that exceeds its marginal cost. Formally, we assume that Firm B can inform a fraction \( q \in [0, 1] \) of the population at a cost \( c(q) \geq 0; q \) represents Firm B’s advertising intensity. We first assume that informed consumers are aware of the benefits that drug B yields but not their own type. Therefore, informed consumers know only drug B’s expected benefit. In the next section we consider how the equilibrium of the model is different if advertising also enables informed consumers to recognize their types.

Because the expected benefit from drug B is higher than the expected benefit from drug A, an informed consumer always chooses to receive drug B if his HMO offers it.

---

7 The proof of this result is available from the authors upon request.
Uninformed consumers, on the other hand, are not aware of the existence of drug B, and they only receive this drug if the HMO chooses to provide it to them. Thus, uninformed consumers may not receive drug B even if their HMO provides it to informed consumers.

The timing of the model is as follows. First, Firm B chooses drug B’s unit price $m_B$ and its advertising intensity $q$. Firm B’s choices must be optimal given that the producers of drug A choose a unit price $m_A = k_A$, i.e. given that the producers of drug A price at marginal cost. After observing $m_A$, $m_B$ and $q$, the two HMOs simultaneously decide which drugs to include in their formularies. Each HMO’s formulary represents the set of drugs that are available to its consumers. Formally, HMO $i$ chooses a set $\Delta_i \subseteq \Delta$, $i \in \{1, 2\}$. For each of its clients who receives drug $z \in \Delta_i$, HMO $i$ bears a cost $m_z$, which is the unit price of drug $z$. We assume that both HMOs must always prescribe some drug to each consumer. Therefore, each HMO must have at least one drug in its formulary. After observing the formulary decisions, the two HMOs simultaneously select their prices. Finally, each consumer purchases health care from one of the HMOs. See Figure 2 for a summary of the model’s timing.

[INSERT FIGURE 2 ABOUT HERE]

In order to characterize the subgame perfect Nash equilibrium of the model, we must analyze the Nash equilibrium of the subgame that follows Firm B’s pricing and advertising decisions. Suppose first that Firm B chooses a higher price than the producers of drug A, i.e. suppose that $m_B > m_A$. Because both HMOs prefer to prescribe the cheapest drug, they will always include drug A in their formularies, if only to prescribe it to consumers who are not aware of drug B. Each HMO must then decide whether or not to permit its informed consumers to consume the more expensive drug B. This decision hinges on the nature of price competition between the two HMOs under the three possible formulary configurations: only one HMO includes both drugs A and B in its formulary, both HMOs offer drugs A and B, and both HMOs offer only drug A.

---

8 Consumers may be aware that treatments exist, even if they are unaware of the benefits associated with particular therapies. Such knowledge may enable consumers to obtain some treatment from their HMOs.
Case 1: Only One HMO Offers Both Drugs A and B

Suppose that HMO 1 offers both drugs A and B while HMO 2 offers only A.\(^9\) Provided that Firm B has chosen a non-zero advertising intensity \((q > 0)\), the two HMOs will face both informed and uninformed consumers. Because Firm B’s advertising communicates the relative merits of drug B over drug A, informed consumers anticipate that they will receive \(\mu \bar{v} + (1 - \mu)v\) from consuming drug B if they purchase health care from HMO 1.\(^10\) They meanwhile anticipate that they will receive \(v\) from consuming drug A if they purchase health care from HMO 2. If HMO \(i\) chooses a price \(p_i, i \in \{1, 2\}\), then the informed consumer who is just indifferent between HMO 1 and HMO 2 is located at \(x_i^*\), where:

\[
x_i^* = \frac{1}{2} + \frac{(p_2 - p_1)}{2t} + \frac{\mu(v - \bar{v})}{2t}.
\]

Informed consumers who are located in the interval \([0, x_i^*]\) will choose HMO 1, and informed consumers who are located in the interval \((x_i^*, 1]\) will choose HMO 2. We assume that the parameter \(t\) is large enough that HMO 2 will serve some informed consumers.

Uninformed consumers anticipate that they will receive the same prescription drug benefit regardless of which HMO they choose; they know that each HMO will simply offer them the cheapest drug that is available. Therefore, the uninformed consumer who is indifferent between HMO 1 and HMO 2 is located at \(x_u^*\), where:

\[
x_u^* = \frac{1}{2} + \frac{(p_2 - p_1)}{2t}.
\]

Uninformed consumers who are located in the interval \([0, x_u^*]\) will patronize HMO 1, and uninformed consumers who are located in the interval \((x_u^*, 1]\) will patronize HMO 2. We

---

\(^9\) Because of the symmetric nature of the model, the results are analogous in the obvious way when only HMO 2 offers both drugs A and B.

\(^10\) For example, a patient who learns from an ad that some symptom he is experiencing is a side effect of a medication may tell the physician and obtain a new drug that does not cause the side effect. Another patient who does not see the ad may not be aware that the symptom is a side effect, and so may not tell the physician.
assume that the parameter $t$ is large enough that HMO 1 will serve some uninformed consumers.

If a fraction $q > 0$ of the population is informed, HMO 1’s demand function is:

$$D_1(p_1, p_2) = \frac{1}{2} + \frac{(p_2 - p_1)}{2t} + \frac{q(\mu - \gamma)}{2t}$$

while HMO 2’s demand is given by $D_2(p_1, p_2) = 1 - D_1(p_1, p_2).$ These demand functions reflect an assumption that the manufacturer of drug B cannot target its advertising to consumers at particular locations. Both informed and uninformed consumers are thus distributed uniformly on the unit interval.

We assume for simplicity that the HMOs produce the composite medical good at zero cost. The unit prices of drugs A and B are, respectively, $m_A$ and $m_B$, and HMO 1’s profit function is therefore

$$\Pi_1(p_1, p_2) = \frac{1}{2} + \frac{p_2 - p_1}{2t} \left(p_1 - qm_B - (1-q)m_A\right) + \frac{q(\mu - \gamma)}{2t}(p_1 - m_B),$$

and HMO 2’s profit function is

$$\Pi_2(p_1, p_2) = \frac{1}{2} + \frac{p_1 - p_2}{2t} - \frac{q(\mu - \gamma)}{2t} \left(p_2 - m_A\right).$$

The unique Nash Equilibrium of the pricing game between the two HMOs is a pair of prices $(p_1^*, p_2^*)$, where:

$$p_1^* = t + qm_B + (1-q)m_A + \frac{q(\mu - \gamma) - (m_B - m_A)}{3},$$

$$p_2^* = t + m_A - \frac{q(\mu - \gamma) - (m_B - m_A)}{3}.$$

The two HMOs’ equilibrium profits are given by

\[11\text{ We assume that the parameter } \alpha \text{ in the utility function } u(d_i, p_i) = \alpha - td_i - p_i \text{ is large enough that, at the equilibrium prices, all consumers purchase health care.} \]
\[
\Pi_1^* = \frac{t}{2} \left[ 1 + \frac{q(\mu(\bar{v} - \bar{y}) - (m_B - m_A))}{3t} \right]^2 - \frac{q(1-q)\mu(\bar{v} - \bar{y})(m_B - m_A)}{2t}
\]
and
\[
\Pi_2^* = \frac{t}{2} \left[ 1 - \frac{q(\mu(\bar{v} - \bar{y}) - (m_B - m_A))}{3t} \right]^2.
\]

We discuss the relative magnitudes of these payoffs below, when we discuss the HMOs’ formulary adoption decisions.

Case 2: Both HMOs Offer Drugs A and B

If both HMOs offer drugs A and B, then the consumer who is indifferent between HMO 1 and HMO 2 is located at
\[
x^* = \frac{1}{2} + \frac{(p_2 - p_1)}{2t},
\]
regardless of whether or not he is informed. HMO 1’s demand function is then
\[
D_1(p_2, p_1) = \frac{1}{2} + \frac{(p_2 - p_1)}{2t},
\]
and HMO 2’s demand function is
\[
D_2(p_1, p_2) = 1 - D_1(p_1, p_2).
\]

HMO 1’s profit function is:
\[
\Pi_1(p_1, p_2) = \left( \frac{1}{2} + \frac{p_2 - p_1}{2t} \right) p_1 - qm_B - (1 - q)m_A,
\]
and HMO 2’s profit function is:
\[
\Pi_2(p_1, p_2) = \left( \frac{1}{2} + \frac{p_1 - p_2}{2t} \right) p_2 - qm_B - (1 - q)m_A.
\]

The unique Nash equilibrium of the pricing game between the two HMOs is the pair of prices \((p_1^*, p_2^*)\), where:
\[
p_1^* = t + qm_B + (1 - q)m_A, \quad p_2^* = t + qm_B + (1 - q)m_A.
\]
The two HMOs’ equilibrium profits are \(\Pi_1^* = \Pi_2^* = \frac{t}{2}\).

Case 3: Both HMOs Offer Only Drug A

If the HMOs offer only drug A, then the consumer who is indifferent between HMO 1 and HMO 2 is located at
\[
x^* = \frac{1}{2} + \frac{(p_2 - p_1)}{2t},
\]
regardless of whether or not he is informed.
In this case, HMO 1’s demand function is \( D_1(p_2, p_1) = \frac{1}{2} + \frac{(p_2 - p_1)}{2t} \), and HMO 2’s demand function is \( D_2(p_1, p_2) = 1 - D_1(p_1, p_2) \). The Nash equilibrium of the pricing game between the two HMOs is the pair of prices \( (p_1^*, p_2^*) \), where:

\[
p_1^* = t + m_A, \quad p_2^* = t + m_A.
\]

The two HMOs’ equilibrium profits are \( \Pi_1^* = \Pi_2^* = \frac{t}{2} \).

We now turn to the HMOs’ formulary choices. As noted above, the hypothesis that \( m_A < m_B \) implies that both HMOs will include drug A in their formularies and prescribe it to any consumer who does not demand drug B. Therefore, each HMO must simply decide whether or not to make drug B available to its informed consumers. When making this choice in a subgame perfect Nash equilibrium of the model, the HMOs anticipate that they will play a Nash equilibrium in the subsequent pricing game. Therefore, the equilibrium profits derived in the analysis of the pricing game determine the payoffs that the HMOs receive as a function of their formulary choices. These payoffs are then the reduced form payoffs of a simultaneous move formulary choice game, which we depict in Figure 3.

An examination of the formulary choice game in Figure 3 reveals that the HMOs play a coordination game when they choose their formularies. Thus, there is no pure strategy equilibrium in which only one of the HMOs offers the drug B. Suppose that HMO 1 prefers to offer drug B when HMO 2 does not offer it. That is, suppose that

\[
\frac{t}{2} \left[ 1 + \frac{q(\mu(\bar{v} - v) - (m_B - m_A))}{3t} \right]^2 - \frac{q(1-q)\mu(\bar{v} - v)(m_B - m_A)}{2t} > \frac{t}{2}.
\]

This inequality is satisfied only if \( m_B < \mu(\bar{v} - v) + m_A \). But then, a fortiori, \( \frac{t}{2} \left[ 1 - \frac{q(\mu(\bar{v} - v) - (m_B - m_A))}{3t} \right]^2 < \frac{t}{2} \), and HMO 2 would also wish to offer drug B. If it is profitable for HMO 1 to offer drug B when HMO 2 does not, then it is profitable for HMO 2 to respond by offering drug B.
after all. The only possible pure strategy equilibria involve both or neither HMOs offering drug B.

We summarize the equilibria of the formulary choice game in the following Proposition.

**Proposition 1:** (i) There is a unique Nash equilibrium of the formulary choice game in which both HMOs offer drug B in their formularies if:

\[
\frac{t}{2} \left[ 1 + \frac{q(\mu(\bar{v} - v) - (m_B - m_A))}{3t} \right]^2 - \frac{q(1-q)\mu(\bar{v} - v)(m_B - m_A)}{2t} > \frac{t}{2}.
\]

(ii) There is a unique Nash equilibrium of the formulary choice game in which neither HMO offers drug B in its formulary if:

\[
\frac{t}{2} \left[ 1 - \frac{q(\mu(\bar{v} - v) - (m_B - m_A))}{3t} \right]^2 > \frac{t}{2}.
\]

(iii) There are two pure strategy Nash equilibria and one mixed strategy Nash equilibrium of the formulary choice game if both:

\[
\frac{t}{2} \left[ 1 + \frac{q(\mu(\bar{v} - v) - (m_B - m_A))}{3t} \right]^2 - \frac{q(1-q)\mu(\bar{v} - v)(m_B - m_A)}{2t} \leq \frac{t}{2} \text{ and }
\]

\[
\frac{t}{2} \left[ 1 - \frac{q(\mu(\bar{v} - v) - (m_B - m_A))}{3t} \right]^2 \leq \frac{t}{2}.
\]

In one pure strategy equilibrium both HMOs offer drug B, and in the other pure strategy equilibrium neither HMO offers drug B.

**Proof:** (i) If

\[
\frac{t}{2} \left[ 1 + \frac{q(\mu(\bar{v} - v) - (m_B - m_A))}{3t} \right]^2 - \frac{q(1-q)\mu(\bar{v} - v)(m_B - m_A)}{2t} > \frac{t}{2},
\]

because \( m_B < \mu(\bar{v} - v) + m_A \), \( \frac{t}{2} \left[ 1 - \frac{q(\mu(\bar{v} - v) - (m_B - m_A))}{3t} \right]^2 < \frac{t}{2} \), and each HMO has a dominant strategy to offer drug B. (ii) If

\[
\frac{t}{2} \left[ 1 - \frac{q(\mu(\bar{v} - v) - (m_B - m_A))}{3t} \right]^2 > \frac{t}{2},
\]

because \( m_B > \mu(\bar{v} - v) + m_A \), \( \frac{t}{2} \left[ 1 + \frac{q(\mu(\bar{v} - v) - (m_B - m_A))}{3t} \right]^2 - \frac{q(1-q)\mu(\bar{v} - v)(m_B - m_A)}{2t} < \frac{t}{2} \), and each HMO has a dominant strategy to offer drug B. (iii) This result is straightforward to verify using the game depicted in Figure 3. QED

The inequality in part (i) of the Proposition identifies the condition that under which each HMO has a dominant strategy of always offering drug B. For a given drug price \( m_B \),
this condition is satisfied when Firm B’s advertising intensity $q > \hat{q}(m_B)$, where $\hat{q}(m_B)$ is implicitly defined by:

$$
\frac{\mu (\bar{v} - v) - (m_B - m_A)}{3} + \frac{q(\mu (\bar{v} - v) - (m_B - m_A))^2}{18t} - \frac{(1-q)\mu (\bar{v} - v)(m_B - m_A)}{2t} = 0
$$

We obtain equation (1) by expanding and simplifying the left-hand side of the inequality in part (i) of the Proposition. Using the implicit function theorem, it is straightforward to verify that $dq/dm_B > 0$. Intuitively, if Firm B chooses a higher price for drug B, the HMOs have less incentive to offer it. Therefore, Firm B must advertise with greater intensity in order to maintain the HMOs’ dominant incentive to offer drug B. In Figure 4, the curve $\Gamma^*$ depicts the graph of $\hat{q}(m_B)$ when $t = \bar{v} = 1$ and $v = m_A = k_A = 0$. To the left of $\Gamma^*$ the condition in (i) is satisfied, and both HMOs have a dominant strategy to offer drug B. If either the price of drug B is sufficiently low or Firm B’s advertising intensity is sufficiently high, each HMO adopts drug B regardless of what it believes about the other HMO’s strategy.

The inequality in part (ii) of Proposition 1 identifies the condition that under which each HMO has a dominant strategy of not offering drug B. This condition is satisfied if and only if $\mu \bar{v} + (1 - \mu) \bar{v} - m_B < \bar{v} - m_A$. The HMOs would thus never include drug B in their formularies if Firm B chooses a unit price that is so high that drug B yields a lower expected surplus net of its price than drug A. In Figure 4 this condition is satisfied to the right of the curve $\Gamma^{**}$.

The following corollary follows immediately from part (ii) of Proposition 1.

**Corollary 1:** HMOs 1 and 2 include drug B in their formularies only if it yields a larger net expected social surplus than drug A, i.e. only if $\mu \bar{v} + (1 - \mu) \bar{v} - k_B \geq \bar{v} - k_A$.

**Proof:** Part (ii) of Proposition 2 establishes that $\mu \bar{v} + (1 - \mu) \bar{v} - m_B \geq \bar{v} - m_A$ is a necessary condition for an HMO to include drug B in its formulary. But $m_A = k_A$ and, furthermore, in order to maximize profits, Firm B must choose $m_B \geq k_B$. Thus, $k_B \leq m_B \leq \mu (\bar{v} - v) + m_A$, or $\mu \bar{v} + (1 - \mu) \bar{v} - k_B \geq \bar{v} - k_A$, implying that HMOs will offer drug B only if it yields a larger net social surplus than drug A.

QED
The Corollary means that consumers receive drug B only if it is socially efficient for the HMOs to prescribe it. The Corollary does not mean, however, that HMOs always offer drug B whenever it is socially efficient to do so. Indeed, if the inequalities in part (iii) of Proposition 1 are satisfied, there are multiple pure strategy equilibria in the formulary adoption game, one in which both HMOs offer B and one in which neither HMO offers B. Furthermore, for values of $m_B$ and $q$ that satisfy these conditions, there is also a mixed strategy equilibrium in which the HMOs randomize between offering and not offering the drug. In this region, each HMO’s optimal formulary choice depends on what it believes its rival will do.

[INSERT FIGURE 4 ABOUT HERE]

Part (iii) of Proposition 1 establishes that the HMOs may not include drug B in their formularies, even if its unit price is low enough that it offers a higher net surplus than drug A, i.e. even if $\mu \bar{\nu} + (1 - \mu)\bar{\nu} - m_B > \bar{\nu} - m_A$. This result is somewhat surprising; it would be reasonable to expect each HMO to be able to increase its profits by offering the drug that yields the highest net surplus. However, if HMO 1 believes that HMO 2 will not include drug B in its formulary, then it must weigh the benefit of being able to attract informed customers against the cost of losing uninformed consumers. HMO 1 loses uninformed consumers because it must increase its price to offset the cost of providing drug B to informed consumers. If HMO 1 were able to price discriminate between the two groups, then it would always wish to offer the drug that provided the highest net benefit to informed consumers. But if HMO 1 cannot price discriminate, it may prefer not to offer drug B at all.

The preceding analysis hinges on the assumption that $m_A < m_B$, i.e. that Firm B charges a higher price for drug B than producers of drug A charge for their product. But Firm B could match or undercut the producers of drug A by choosing a price $m_B \leq m_A = k_A$. Because the HMOs prefer to prescribe the cheapest possible drug, they would then offer
only drug B, even if Firm B foregoes advertising. Clearly, this strategy is potentially profitable for Firm B only if $k_A > k_B$.

We now analyze Firm B’s best reply. In a subgame perfect Nash equilibrium of the model, Firm B anticipates that each possible choice of $m_B$ and $q$ will implement a particular Nash equilibrium of the formulary choice game. Firm B’s preferred strategy is the combination of price and advertising intensity that maximizes its expected profits. As we just noted, Firm B could choose to undercut the producers of drug A and forego advertising. Assuming that the HMOs prescribe drug B when they are indifferent between the two drugs, Firm B would then choose a price $m_B = k_A$ and earn a profit $\Pi_B = k_A - k_B$. In order to identify Firm B’s best reply, we must compare the profit $\Pi_B = k_A - k_B$ with the highest profit that Firm B can earn by choosing a price $m_B > m_A$.

All else equal, Firm B wishes to choose the highest possible price, $m_B$. But Firm B may not wish to choose $m_B = \mu(\bar{v} - \underline{v}) + m_A$, even though this is the highest price such that there exists an equilibrium in which the HMOs adopt drug B. When the inequalities in part (iii) of Proposition 2 are satisfied, as they are when $m_B = \mu(\bar{v} - \underline{v}) + m_A$, there are multiple equilibria of the HMOs formulary adoption game. But then Firm B’s optimal choice depends on which of the equilibria the HMOs play for each combination of $m_B$ and $q$.

Consider the following two polar cases. First, suppose that the HMOs always include drug B in their formularies when the inequalities in part (iii) of Proposition 2 are satisfied. Then Firm B chooses $m_B$ and $q$ to maximize its profit, $\Pi_B = q(m_B - k_B) - c(q)$, subject to the constraint that $m_B \leq \mu(\bar{v} - \underline{v}) + m_A$. We assume that $c', c'' > 0$, and therefore Firm B’s objective function is a strictly concave function of $q$. Firm B’s optimal price is $m_B^* = \mu(\bar{v} - \underline{v}) + m_A$, and the optimal advertising intensity is $q^* = \arg\max_{q \in [0, 1]} q[\mu(\bar{v} - \underline{v}) + m_A - k_B] - c(q)$.

Now consider the other polar case, in which the HMOs choose not to offer drug B if the inequalities in part (iii) of Proposition 1 are both strictly satisfied. Then Firm B’s preferred price $m_B$ and advertising intensity $q$ maximize $\Pi_B = q(m_B - k_B) - c(q)$ subject to

---

12 In order for Firm B’s maximization problem to be well defined, we assume that the HMOs adopt drug B when $q = \hat{q}(m_B)$. 

the constraint \( \frac{t}{2} \left[ \frac{q(\mu - \nu - (m_B - m_A))}{3t} \right]^2 - \frac{q(1-q)\mu(\nu - \nu)(m_B - m_A)}{2t} = \frac{t}{2} \). In this case, Firm B chooses its preferred combination of price and advertising intensity from along the curve \( \Gamma^* \) in Figure 4.

**An Example**

Suppose that \( t = \bar{\nu} = \mu = 1, \nu = k_A = m_A = k_B = 0 \), and \( c(q) = q/4(1 - q) \). Suppose further that the HMOs always offer drug B when the inequalities of part (iii) of Proposition 1 are satisfied. Then firm B’s optimal price is \( m_B = \mu(\nu - \nu) + m_A = 1 \). Firm B's optimal advertising intensity is \( q^* = \arg\max q - (q/4(1 - q)) = 0.5 \). We depict Firm B's optimal choice in Figure 5. The curve \( U^* \) represents Firm B's highest iso-profit locus in this case.

Now suppose that HMOs only offer drug B when it is a weakly dominant strategy to do so, i.e. when

\[
(2) \quad \frac{t}{2} \left[ \frac{q(\mu - \nu - (m_B - m_A))}{3t} \right]^2 - \frac{q(1-q)\mu(\nu - \nu)(m_B - m_A)}{2t} \geq \frac{t}{2}.
\]

In this case Firm B chooses its price \( m_B \) and advertising intensity \( q \) in order to maximize \( \Pi(m_B, q) = qm_B - q/4(1 - q) \) subject to the constraint given in equation (2). Now Firm B’s best reply is a price \( m_B^* = .53739 \) and an advertising intensity \( q^* = .408047 \). We depict Firm B's optimal choice in Figure 5. The curve \( U^{**} \) represents Firm B's highest iso-profit locus in this case.

The example shows how the existence of multiple Nash equilibria in the HMOs’ formulary choice subgames gives rise to multiple equilibria in the game between Firm B and the HMOs. Firm B’s best reply depends on which Nash equilibrium the HMOs play in each formulary choice subgame. Furthermore, no equilibrium refinement selects a unique equilibrium in the HMOs’ formulary choice subgames.

---

13 We used Mathematica v. 3.0.1 to find the solution to Firm B's optimization problem.
The existence of multiple equilibria in the HMOs formulary choice game raises the possibility that Firm B will not choose the socially optimal level of advertising. Suppose that drug B both costs more to produce and yields a higher net expected surplus than drug A. That is, suppose that \( k_B > k_A \) and \( \mu \bar{v} + (1 - \mu)v - k_B \geq v - k_A \). While it is then optimal for all consumers to receive drug B, Firm B is unable to undercut the producers of drug A, and only informed consumers will receive drug B. If both HMOs offer drug B and, therefore, all informed consumers receive it, total expected consumer and producer surplus from the consumption of prescription drugs is:

\[
q(\mu \bar{v} + (1 - \mu)v - m_B) + q(m_B - k_B) - c(q) + (1 - q)(v - k_A) = (v - k_A) + q(\mu(\bar{v} - v) + k_A - k_B) - c(q).
\]

The socially optimal advertising intensity, say \( q_{opt} \), then satisfies \( (\mu(\bar{v} - v) + k_A - k_B) - c'(q_{opt}) = 0 \). Because \( m_A = k_A \), Firm B has a socially optimal incentive to advertise when \( m_B = \mu(\bar{v} - v) + m_A \), but Proposition 1 establishes that there are multiple equilibria of the formulary choice subgame for this price-advertising intensity combination. If the HMOs play the equilibrium in which they do not offer drug B, Firm B will not in general have a socially optimal incentive to advertise.

Despite the fact that no equilibrium refinement selects a unique equilibrium in each formulary choice subgame, we nevertheless argue that it may be sensible to restrict our attention to the equilibrium in which the HMOs choose to include drug B in their formularies when the inequalities in part (iii) of Proposition 1 are satisfied. In this equilibrium, the HMOs adopt drug B whenever \( m_B \leq \mu(\bar{v} - v) + m_A \). In order to make this argument, we examine the welfare properties of the pure strategy Nash equilibria of the formulary choice subgame that arises when, given Firm B’s price \( m_B > m_A \) and advertising intensity \( q \), the inequalities in part (iii) of Proposition 1 are satisfied.  

Suppose first that the HMOs play the equilibrium in which they both offer drug B in these subgames. Then HMO \( i \in \{1, 2\} \) earns a profit \( \Pi_i = t/2 \), and total consumer surplus is \( CS = \alpha - 1.25t - qm_B - (1 - q)m_A + q\mu \bar{v} + (1 - q\mu)v \). An individual informed consumer

---

14 We reach the same conclusions if we include in our analysis the mixed strategy equilibrium of the formulary choice subgame.
receives $\alpha - 1.25t - qm_B - (1 - q)m_A + \mu \bar{v} + (1 - \mu)v$, while an individual uninformed consumer receives $\alpha - 1.25t - qm_B - (1 - q)m_A + v$. Informed consumers receive a higher payoff than uninformed consumers. The consumer surplus calculations reflect the HMOs' prices, equilibrium transportation costs, and the expected benefits that consumers receive from consuming prescription drugs.

Now suppose that the HMOs play the equilibrium in which they do not offer drug B in these subgames. Once again each HMO earns a profit of $t/2$, but now consumer surplus is $CS = \alpha - 1.25t - m_A + v$. Informed and uninformed consumers now receive the same payoff.

The HMOs are clearly indifferent between the two pure strategy equilibria of these formulary choice subgames. But, because $\mu \bar{v} + (1 - \mu)v - m_B \geq v - m_A$ when the inequalities in part (iii) of Proposition 1 are satisfied, it follows that total consumer surplus is greater if the HMOs play the equilibrium of the formulary choice subgame in which they adopt drug B. We thus conclude that consumers overall are better off if the HMOs play this equilibrium, though we qualify this conclusion with the observation that, because $m_B > m_A$, uninformed consumers are worse off if the HMOs offer drug B to informed consumers. Uninformed consumers pay a higher price as a result of the HMOs' higher costs, but they do not receive the benefit of the superior drug.

While in the present model there is no formal mechanism that would lead the players to coordinate on the equilibrium in which the HMOs always offer drug B when $m_B \leq \mu(\bar{v} - v) + m_A$, employers or other group purchasers of health care may play such a role in real-world medical markets. For example, an employer may be able to commit itself to offer only health plans that make certain therapies available to its employees.

For simplicity, we characterize the model's subgame perfect Nash equilibrium under the assumption that the HMOs include drug B in their formularies whenever $m_B \leq \mu(\bar{v} - v) + m_A$. 
Proposition 2: Suppose that the HMOs offer drug B whenever \( m_B \leq \mu(\bar{v} - \bar{y}) + m_A \). (i) Suppose that \( \mu(\bar{v} - \bar{y}) < k_B - k_A \). Then there exists no Nash equilibrium in which the HMOs offer drug B. (ii) Suppose that \( \mu(\bar{v} - \bar{y}) \geq k_B - k_A \) and \( k_A - k_B \geq \max_{q \in [0, 1]} q[\mu(\bar{v} - \bar{y}) - k_B + k_A] - c(q) \). Then Firm B chooses a price \( m_B^* = k_A \) and an advertising intensity \( q^* = 0 \). All consumers receive drug B. (iii) Suppose that \( \mu(\bar{v} - \bar{y}) \geq k_B - k_A \) and \( k_A - k_B < \max_{q \in [0, 1]} q[\mu(\bar{v} - \bar{y}) - k_B + k_A] - c(q) \). Then Firm B chooses a price \( m_B^* = \mu(\bar{v} - \bar{y}) + k_A \) and an advertising intensity \( q^* = \arg\max_{q \in [0, 1]} q[\mu(\bar{v} - \bar{y}) - k_B + k_A] - c(q) \). The HMOs include both drugs A and B in their formularies; \( q^* \) consumers receive drug B, and \( 1 - q^* \) consumers receive drug A.

Proof: (i) Because \( m_A = k_A \) and \( m_B \geq k_B \), the hypothesis implies that, for Firm B to profitably offer drug B, we must have \( \mu(\bar{v} - \bar{y}) < m_B - m_A \). But then it follows from part (ii) of Proposition 1 that there is no Nash equilibrium in which the HMOs offer drug B. Parts (ii) and (iii) follow obviously from the hypotheses.

Part (i) of Proposition 2 establishes that the HMOs never offer drug B when the difference between the expected benefits that the two drugs offer (\( \mu(\bar{v} - \bar{y}) \)) is less than the difference between their marginal costs (\( k_B - k_A \)). This result follows from the fact that, if Firm B chooses a price that is high enough to cover its costs, the difference between drug B’s price and drug A’s price equals or exceeds the difference between their marginal costs.\(^{15}\) But an HMO never finds it profitable to adopt drug B if its price exceeds drug A’s price by more than the difference between the drugs’ expected benefits to consumers. If drug B offers such a small improvement over drug A, consumers’ increased willingness to pay for medical care if they are able to consume drug B does not offset an HMO’s increased costs from including it in the formulary.

Parts (ii) and (iii) of Proposition 2 show that Firm B can use either a low price or advertising to encourage the adoption of drug B. If Firm B prices drug B below drug A, the HMOs adopt and prescribe drug B even if there is no advertising. If Firm B prices drug B above drug A, meanwhile, the HMOs prefer to offer only the cheaper drug to their consumers. Firm B must therefore use advertising to overcome the HMOs’ reluctance to offer drug B. The general nature of these results — that Firm B can use either a low price or advertising to encourage the adoption of drug B — is unchanged if we relax the assumption that the HMOs adopt drug B whenever \( m_B \leq \mu(\bar{v} - \bar{y}) + m_A \). If we relax this

\(^{15}\) Recall that producers of drug A price at marginal cost.
assumption, though, Firm B’s optimal price and advertising intensity would depend on which equilibrium the HMOs play in the different formulary choice subgames.

We now analyze how a change in the cost of advertising affects the model’s equilibrium. This is a particularly important policy question because FDA policies greatly increase the cost of advertising pharmaceuticals. These policies require that print advertisements addressed to consumers follow the same guidelines as advertisements to professionals, such as the inclusion of a so-called “brief summary” if an ad mentions both the existence of a drug and its use. As a result, print ads cost approximately twice as much as they would cost without the requirement, since the brief summary is generally about as long as the ad. Until recently, broadcast ads were covered by the same restrictions, making them difficult to produce. Commercials mentioned only the drug, with no indication of its use, or only the use, with no mention of the drug. These restrictions obviously greatly reduced the effectiveness of such ads and increased the real cost. In August, 1997, the FDA announced that pharmaceutical manufacturers would be able to use television commercials to advertise the existence of a drug and its use without having to include the brief summary. (Ingersoll and Ono, 1997)

Suppose that there are two alternative advertising cost functions, \( c_H(\cdot) \) and \( c_L(\cdot) \), where \( c_H(0) = c_L(0) = 0, c_H' > c_L' > 0, \) and \( c_j'' > 0, j \in \{H, L\} \). Define \( q_j^*, j \in \{H, L\} \), as the equilibrium level of advertising under the alternative cost functions.

**Proposition 3:** Suppose that \( c_H(0) = c_L(0), c_H'(q) > c_L'(q) > 0, \) and \( c''_j(q) > 0, \forall q \in [0, 1] \) and \( j \in \{H, L\} \). Then \( q_L^* \leq q_H^* \), i.e. there is more advertising when the marginal cost of advertising falls.

**Proof:** Let \( m_H^* \) and \( q_H^* \) be Firm B’s optimal price and advertising intensity when the advertising cost function is \( c_H(\cdot) \). Now suppose to the contrary that, when the advertising cost function is \( c_L(\cdot) \), Firm B’s optimal advertising intensity \( q_L^* \leq q_H^* \). By revealed preference, it must be that \( c_L(q_H^*) - c_L(q_L^*) > q_H^*(m_H^* - k_B) - q_L^*(m_L^* - k_B) \), where \( m_L^* \) is Firm B’s optimal price under the advertising cost function \( c_L \). The hypothesis that \( c_H'(q) > c'_L(q) \) implies that \( c_H(q_H^*) - c_H(q_L^*) > c_L(q_H^*) - c_L(q_L^*) \). But then \( c_H(q_H^*) - c_H(q_L^*) > q_H^*(m_H^* - k_B) - q_L^*(m_L^* - k_B) \), contradicting the optimality of \( m_H^* \) and \( q_H^* \) under the advertising cost function \( c_H \). Thus, we must have \( q_L^* \leq q_H^* \). QED
Not surprisingly, a reduction in the marginal cost of advertising leads Firm B to choose a higher advertising intensity. This conclusion holds regardless of which equilibrium the HMOs play in the formulary choice subgames. While this effect may improve welfare by increasing the number of consumers who receive drug B, it is possible that the increased advertising will be socially inefficient in our static model in which the set of available drugs is fixed. Suppose that when the cost of advertising is high, Firm B foregoes advertising completely in favor of choosing a low price $m_B^* = k_A$. In this case all consumers receive drug B, as is socially efficient.\(^\text{16}\) If the cost of advertising declines, though, it may be optimal for Firm B to choose a high price $m_B > k_A$ and advertise. But then only a fraction of consumers will receive drug B. Firm B’s new strategy imposes two welfare losses: fewer consumers receive drug B, and socially wasteful advertising occurs.

There is, however, a countervailing benefit that arises when a reduction in advertising costs leads Firm B to switch from a low price/no advertising to a high price/advertising strategy. The increase in profits presumably spurs the development of new drugs. While a reduction in advertising costs may hurt welfare in a static model, this result may be less likely in a dynamic model, though a thorough analysis of this question is outside the scope of this paper.

In order for a reduction in the cost of advertising to reduce welfare, the marginal cost of drug B must be less than the marginal cost of drug A. It is only when $k_B < k_A$ that a “low price/no advertising” strategy is available to Firm B. There are several reasons why this is unlikely to be the case. First, the marginal cost of the generic drug (off-patent) drug A may have decreased as a result of learning effects. Second, the marginal cost of the patented drug B may include significant promotion costs. If $k_B > k_A$, then the welfare effects of a reduction in the price of advertising will be unambiguously positive, provided that the HMOs always adopt drug B when $m_B \leq \mu(\bar{v} - v) + m_A$.

\(^\text{16}\) We point out that this can be profitable for Firm B when $k_B < k_A$. Therefore, it is socially desirable for all consumers to receive drug B, both because it is the low-cost drug and because it offers a higher expected benefit.
3. An Extension: Advertising that Enables Consumer to Recognize His Type

In this section we analyze the effect of advertising that enables a consumer to learn his type \( \theta_y \in \{ \theta_1, \theta_2 \} \). Recall that a consumer of type \( \theta_1 \) receives a benefit \( v_1^B = \bar{v} \) from consuming drug B, while a consumer of type \( \theta_2 \) receives a benefit \( v_2^B = v \). Both types receive a benefit \( v \) from consuming drug A. The intuition for the payoffs is straightforward. Consumers of type \( \theta_1 \) either suffer fewer side effects or receive more therapeutic benefits if they consume drug B. Our premise in this section is that a consumer may possess information about himself that could enable him to identify his type and, hence, his actual benefit from consuming drug B. If so, there may be a role for advertising that explains to consumers the relationship between the information that they have and the different possible benefits they could receive from drug B.

Only consumers of type \( \theta_1 \) would benefit from receiving drug B. We therefore assume that, when informed consumers observe their types, only consumers of type \( \theta_1 \) ever demand drug B. Consumers who know that they will not benefit from drug B do not request it, even if their HMOs include it in their formularies. It is straightforward to analyze as before the different possible pricing games under the assumption that the \( q \) informed consumers observe their types.\(^{17}\) This analysis yields the payoffs for the new formulary choice game, which we depict in Figure 6.

\[ \text{[INSERT FIGURE 6 ABOUT HERE]} \]

We summarize the Nash equilibria of the new formulary choice game in the following proposition.

---

\(^{17}\) We omit this analysis in order to save space. It is analogous to the corresponding analysis in the previous section. Details are available upon request from the authors.
Proposition 4: (i) There is a unique Nash equilibrium of the formulary choice game in which both HMOs offer drug B in their formularies if:

\[
\frac{t}{2} \left[ 1 + \frac{q\mu((\bar{v} - v) - (m_B - m_A))}{3t} \right]^2 - \frac{q\mu(1-q\mu)(\bar{v} - v)(m_B - m_A)}{2t} > \frac{t}{2}.
\]

(ii) There is a unique Nash equilibrium of the formulary choice game in which neither HMO offers drug B if:

\[
\frac{t}{2} \left[ 1 - \frac{q\mu((\bar{v} - v) - (m_B - m_A))}{3t} \right]^2 > \frac{t}{2}.
\]

(iii) There are two pure strategy Nash equilibria and one mixed strategy Nash equilibrium of the formulary choice game if both:

\[
\frac{t}{2} \left[ 1 + \frac{q\mu((\bar{v} - v) - (m_B - m_A))}{3t} \right]^2 - \frac{q\mu(1-q\mu)(\bar{v} - v)(m_B - m_A)}{2t} \leq \frac{t}{2} \quad \text{and} \quad \frac{t}{2} \left[ 1 - \frac{q\mu((\bar{v} - v) - (m_B - m_A))}{3t} \right]^2 \leq \frac{t}{2}.
\]

In one pure strategy equilibrium both HMOs offer drug B, and in the other equilibrium neither HMO offers drug B.

Proof: Analogous to proof of Proposition 1. QED

The proposition implies that there exists an equilibrium in which the HMOs both offer drug B if and only if $m_B \leq \bar{v} - v + m_A$. The proposition demonstrates also that, as before, there are multiple equilibria of the formulary choice game for some of the drug price and advertising intensity combinations that Firm B could choose.

Clearly, Firm B may be able to choose a higher price for drug B when consumers have more information about the benefits that they receive from drug B. When consumers cannot recognize their types, HMOs adopt drug B only if Firm B's price $m_B \leq \mu(\bar{v} - v) + m_A$. When consumers can recognize their types, the HMOs adopt drug B only if $m_B \leq (\bar{v} - v) + m_A$.

If Firm B can charge a higher price for its product, it may also earn higher profits when consumers are able to recognize their types. But then Firm B may wish to use its advertising to provide consumers with information that enables them to recognize their types and, therefore, to identify the exact benefits that they receive from consuming drug
B. In the following proposition, we identify circumstances in which Firm B would benefit from providing consumers with this information.

Proposition 5: (i) Suppose that \( \mu(\bar{v} - \bar{y}) < k_B - k_A \) and that \( \bar{v} - \bar{y} \geq k_B - k_A \). Then Firm B prefers for consumers to be able to recognize their types. (ii) Suppose that \( k_B \geq k_A \), that the HMOs offer drug B whenever \( m_B \leq \mu(\bar{v} - \bar{y}) + m_A \) and consumers cannot recognize their types, and that the HMOs offer drug B whenever \( m_B \leq \bar{v} - \bar{y} + m_A \) and consumers can recognize their types. Then Firm B prefers for consumers to be able to recognize their types.

Proof: (i) Because \( \mu(\bar{v} - \bar{y}) < k_B - k_A \), it follows from Proposition 2 that, when consumers cannot recognize their types, there is no subgame perfect Nash equilibrium (SPNE) in which the HMOs offer drug B and Firm B therefore earns zero. Because there is a SPNE in which the HMOs offer drug B when \( \bar{v} - \bar{y} \geq k_B - k_A \) and consumers can recognize their types, Firm B may earn a higher profit in this case. (ii) When consumers cannot recognize their types, Firm B earns \( \Pi^\ast = \max_{q \in [0, 1]} q(\mu(\bar{v} - \bar{y}) + k_A - k_B) - c(q) \). When consumers can recognize their types, Firm B earns \( \Pi^{**} = \max_{q \in [0, 1]} q\mu(\bar{v} - \bar{y} + k_A - k_B) - c(q) \). When \( k_B \geq k_A \), \( \mu(\bar{v} - \bar{y} + k_A - k_B) \geq \mu(\bar{v} - \bar{y}) + k_A - k_B \), and it follows that \( \Pi^{**} \geq \Pi^\ast \). QED

If the hypotheses of part (i) of the Proposition are satisfied, then, as established in Proposition 2, there is no equilibrium in which consumers receive drug B when they cannot recognize their types. Given consumers’ low expected benefit from consuming B, HMOs only find it profitable to adopt the drug if its price is also relatively low, and Firm B cannot profitably sell it at that price. When informed consumers can recognize the exact benefits that they receive from drug B, some of them — those of type \( \theta_1 \) — know that they will receive a high benefit \( \bar{v} \) from drug B, and these are the only consumers who would receive drug B if it were included in the formulary. The HMOs are willing to pay a higher price to buy drugs for this smaller group. Given the hypotheses of part (i), Firm B finds it profitable to offer drug B at this higher price. Furthermore, the hypothesis that \( \bar{v} - \bar{y} \geq k_B - k_A \) means that it is socially optimal for informed consumers of type \( \theta_1 \) to receive drug B.

When the hypotheses of part (ii) of the Proposition are satisfied, Firm B is again better off when consumers are able to recognize the exact benefits that they receive from drug B. Although Firm B sells fewer units compared to when consumers cannot recognize their types, its revenues fall by less than its costs because it is able to charge a higher unit price for drug B. This result hinges to some extent on the hypothesis that, when there are
multiple equilibria in the formulary choice game, the HMOs play the equilibrium in which they offer drug B. Nevertheless, the general finding that Firm B does not necessarily earn lower profits when it sells to fewer (and better informed) consumers remains valid even if we relax this hypothesis. Firm B does not in general benefit from selling its product to consumers who do not need it.

4. Discussion and Concluding Remarks

Our results demonstrate that advertising may enable consumers to overcome the agency conflict that exists in their relationship with managed health care providers. While our formal model addresses the conflict between consumers and providers of managed health care, the point that we make is more general. In our model, advertising disseminates information about beneficial drugs to consumers, and HMOs have an incentive to include these drugs in their formularies in order to make their health plans more attractive to informed consumers. Unfortunately, pharmaceutical manufacturers may not have the incentive to choose the socially optimal combination of price and advertising.

Our results also demonstrate that the decisions by different HMOs to adopt certain therapies are interrelated; each HMO may wish to offer a drug only if its competitors also offer the drug. The strategic nature of drug adoption decisions raises the possibility that there will be a “coordination failure,” meaning that a group of competing health care providers may play a Pareto dominated equilibrium in which they do not offer a beneficial drug. As mentioned above, employers may be able to help managed care providers coordinate on the Pareto preferred equilibrium. Pharmaceutical benefit managers (PBMs) could also potentially play such a coordinating role. A PBM is a firm that contracts with different HMOs to provide their members with pharmaceutical benefits. If a PBM were able to commit itself to include socially efficient drugs in the benefit package that it offered to each HMO, managed health care providers may be led to coordinate on the Pareto preferred equilibrium of their drug adoption game. Further research is needed to assess more fully the incentives of these third-party providers of drug benefits.  

---

18 Because drug companies have an interest in the products that managed care companies offer, they may wish to integrate forward into the PBM industry if third-party providers of drug benefits can help
In our model, we assume that there are only two drugs. One drug is off-patent and produced competitively, while the other drug is protected by a patent and produced by a monopolist. In a more realistic model, several drug manufacturers would use both price and advertisements to compete for inclusion in HMOs’ formularies. We conjecture that our main conclusions would not change in this more complicated model. Advertising could still induce HMOs to offer drugs that they might otherwise exclude from their formularies. Nevertheless, it is unlikely that only the socially efficient drug would have an incentive to advertise. Intuitively, if the producer of the most cost-effective treatment for a particular ailment is unable to reach the entire population with its advertisements, there may remain a market for less cost-effective medications. Producers of these drugs may wish to use advertisements to stimulate demand for their products. Of course, consumers still benefit from these advertisements if they would receive even less effective treatments without the information that they obtain from the advertisements.

Past regulation of pharmaceutical advertising clearly has limited the amount of information that consumers receive about the medications that exist to treat different conditions. This policy imposed costs on consumers even when health care was financed by fee-for-service insurance plans, which encouraged the excessive provision of care. As managed health care spreads, and with it the agency conflicts that exist between patients and HMOs, consumers may find that ignorance is significantly more costly than before. Consumers need information in order to monitor the quality of care that they receive. Ideally, the goal of any policy regulating drug advertising should be to place this information in the hands of the people who need it.
REFERENCES


Figure 1: Uniform Distribution of Consumers

Figure 2: Timing of the Model
### Figure 3: Formulary Choice Game

<table>
<thead>
<tr>
<th></th>
<th>HMO 2</th>
<th>HMO 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Don't Offer B</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Pi_1 )</td>
<td>( \frac{t}{2} )</td>
<td>( \frac{t}{2} )</td>
</tr>
<tr>
<td>( \Pi_2 )</td>
<td>( \frac{t}{2} )</td>
<td>( \frac{t}{2} )</td>
</tr>
<tr>
<td><strong>Offer B</strong></td>
<td>( \Pi_1 )</td>
<td>( \frac{t}{2} )</td>
</tr>
<tr>
<td></td>
<td>( \frac{t}{2} )</td>
<td>( \frac{t}{2} )</td>
</tr>
</tbody>
</table>

\[
\Pi_1^* = \frac{t}{2} \left[ 1 - \frac{g(\mu(\bar{r}-\nu) - (m_B - m_A))}{3t} \right]^2 \\
\Pi_2^* = \frac{t}{2} \left[ 1 + \frac{g(\mu(\bar{r}-\nu) - (m_B - m_A))}{3t} \right]^2 \\
- \frac{q(1-q)\mu(\bar{r}-\nu)(m_B - m_A)}{2t}
\]

\[
\Pi_1^* = \frac{t}{2} \left[ 1 + \frac{g(\mu(\bar{r}-\nu) - (m_B - m_A))}{3t} \right]^2 \\
- \frac{q(1-q)\mu(\bar{r}-\nu)(m_B - m_A)}{2t}
\]

\[
\Pi_2^* = \frac{t}{2} \left[ 1 - \frac{g(\mu(\bar{r}-\nu) - (m_B - m_A))}{3t} \right]^2 \\
\]
Both HMOs Offer Drug B

Neither HMO Offers Drug B

One, Both, or Neither HMO Offers Drug B

Figure 4: Equilibrium of Formulary Adoption Game
### HMO 2

<table>
<thead>
<tr>
<th></th>
<th>Don't Offer B</th>
<th>Offer B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HMO 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Don't Offer B</td>
<td>$\Pi_1^* = \frac{t}{2'}, \Pi_2^* = \frac{t}{2}$</td>
<td>$\Pi_1^* = \frac{t}{2'} \left[ 1 - \frac{q\mu((\bar{v} - v) - (m_B - m_A))}{3t} \right]^2$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$\Pi_2^* = \frac{t}{2'} \left[ 1 + \frac{q\mu((\bar{v} - v) - (m_B - m_A))}{3t} \right]^2$</td>
</tr>
<tr>
<td></td>
<td>$\Pi_1^* = \frac{t}{2'} \left[ 1 - \frac{q\mu((\bar{v} - v) - (m_B - m_A))}{3t} \right]^2$</td>
<td>$- \frac{q\mu(1-q\mu)(\bar{v} - v)(m_B - m_A)}{2t}$</td>
</tr>
<tr>
<td>Offer B</td>
<td>$\Pi_2^* = \frac{t}{2'}$</td>
<td>$\Pi_1^* = \frac{t}{2'}, \Pi_2^* = \frac{t}{2}$</td>
</tr>
</tbody>
</table>

$\Pi_1^* = \frac{t}{2'} \left[ 1 - \frac{q\mu((\bar{v} - v) - (m_B - m_A))}{3t} \right]^2$

$\Pi_2^* = \frac{t}{2'} \left[ 1 + \frac{q\mu((\bar{v} - v) - (m_B - m_A))}{3t} \right]^2$

$- \frac{q\mu(1-q\mu)(\bar{v} - v)(m_B - m_A)}{2t}$

Figure 6: Formulary Choice Game When Consumers Observe Their Types