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Moral Hazard, Market Power, and Second Best Health Insurance

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Abstract

Individual moral hazard engendered by health insurance and monopolistic production are both typical phenomena of drug markets. We develop a simple model containing these two elements and evaluate the market equilibrium on the basis of consumer and social welfare. The consumer welfare criterion suggests that in the market equilibrium individuals purchase too much insurance against the risk of drug expenses. In contrast, the social welfare criterion suggests that individuals should purchase more insurance coverage than they choose to do in the market equilibrium.

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1. Introduction

Since information about true individual losses of illness can hardly be observed by insurers, standard insurance contracts link insurance benefits to the costs of health care services incurred by the insured. Such contracts induce the insured to excessively consume health care services in the sense that they will consume these services beyond the point where marginal benefits equal marginal costs. This behavior, known as ex-post moral hazard, is an unavoidable consequence of constrained information that renders the outcome in the health insurance market only second best [see, e.g., Arrow (1968), Pauly (1968, 1974), and Zeckhauser (1970)]. Feldstein (1970, 1973) pointed out that there is a further source of inefficiency associated with information constrained insurance contracts. Excessive health care consumption is not only inefficient as such, it may also force up prices in health care markets. As the single individual has no incentive to take account of the price increasing effect when purchasing health insurance, the outcome in the health insurance market may not even be efficient in a second best sense. Rationing of health insurance bears the potential to raise consumer welfare as all individuals would benefit from lower prices for health care services. Employing data of US health care markets, Feldstein demonstrated that there would be a substantial welfare gain if US households on average purchased less health insurance. The utility loss from higher risk bearing would be strictly dominated by the gain due to lower prices in health care markets and reduced excess demand for health care services. The finding of Feldstein were reaffirmed by Feldman and Dowd (1991) on the basis of more recent data. Building on these studies, Chiu (1997) showed that in case of a complete price-inelastic supply of health care services consumers should even completely refrain from health insurance.

The above cited studies restricted attention to consumer welfare. They were not concerned with the welfare effects of a change in profits of the health services industry which possibly obtains when consumers purchase less health services because of reduced insurance coverage. The studies either explicitly or implicitly assumed that the health industry profit dimension of reduced health insurance coverage is negligible [Feldstein (1973) confined attention to nonprofit health care organizations which charge average cost prices]. However, casual observation suggests that at least some health care markets exhibit considerable supply side market power. Especially the markets for prescription drugs are dominated by firms

being endowed with far-reaching patent protection that guarantees monopolistic positions in particular drug markets. As there is substantial empirical evidence for insurance induced moral hazard with respect to prescription drugs [see, e.g., Coulson and Stuart (1995)], excess demand is likely to meet monopolistic and, hence, deficient supply in drug markets.

The purpose of this paper is to examine the normative properties of the individuals' choice of insurance against the risk of drug expenses in the presence of a monopolistic drug industry.¹ Since profits in the drug industry can be expected to be substantial, we evaluate the market outcome both in terms of consumer welfare and in terms of social welfare. The latter concept takes explicit account of the welfare impact of profits in the drug industry. We show that the market outcome is not second-best, neither in terms of consumer nor in terms of social welfare. Most strikingly, however, the two normative criteria lead to mutually exclusive strategies of how to improve the market outcome. The consumer welfare criterion suggests that individuals purchase too much insurance coverage against the risk of drug expenses so that rationing of health insurance would improve the allocation. In contrast, under the social welfare criterion the outcome in the health insurance market is characterized by too little insurance coverage. Although there is an insurance induced distortion in drug demand, the exercise of monopoly power leads to inefficiently low drug consumption which can be removed by additional health insurance coverage.

2. The Model

Consider an economy with a unit-measure continuum of ex ante identical individuals. A representative individual has a probability $\pi \in (0, 1)$ of getting ill. When ill the individual suffers a loss which can be reduced by the consumption of

¹ Recently, Gaynor, Haas-Wilson and Vogt (2000) raised a related issue. They analyzed whether an increase in the price for medical goods may be beneficial if demand for medical goods is distorted by insurance induced moral hazard. Gaynor et al. demonstrated that if insurance markets are competitive, welfare is higher under lower than under higher medical goods prices. In the present paper we consider the other side of the coin. Rather than asking whether imperfect competition in the medical goods markets has a welfare enhancing effect, we ask whether rationing in the insurance market is beneficial if medical goods markets are not competitive.

a drug. The individual has the opportunity to purchase insurance against the risk of drug expenses. The individual's expected utility is given by:

$$Eu = \pi u(y - z - l - \lambda p x) + (1 - \pi) u(y - z), \quad (1)$$

where u denotes a von Neumann-Morgenstern utility function with $u' > 0$ and $u'' < 0$, y is the individual's disposable income, z is the insurance premium, x is the quantity of the drug consumed in case of illness, p is the price of the drug, and λ is the coinsurance rate, i.e. the fraction of health expenses borne by the individual. The loss in case of illness amounts to l currency units. As the loss can be reduced by drug consumption, l may be written as a function $l = l(x)$. This specification of the loss facilitates the analysis as it rules out ex post income effects of a change in the drug price on drug demand. Since the present paper focuses on the welfare aspects of insurance against the risk of drug expenses, such a restriction seems to be appropriate as it isolates the substitution effect of an insurance induced change in the drug price on the demand for drugs.² The function l is assumed to be smooth and to satisfy the following monotonicity, convexity and Inada assumptions: $l > 0$, $l' < 0$, $l'(0) = -\infty$, and $l'' > 0$. These assumptions imply diminishing marginal benefits of drug consumption in restoring the individual's health and rule out a corner solution with respect to the consumed amount of drugs in case of illness.

The loss l is private information of sick individuals so that a contract between the insurer and the insured cannot depend on l . Instead, only the drug expenses in case of illness, $p x$, can be subject of an insurance contract. We restrict attention to linear insurance contracts implying that the insurer reimburses a constant share of drug expenses.³ There is perfect competition in the insurance market so that residual profits of insurance companies are zero. If insurers encounter no administrative costs, insurance premiums are determined by:

$$z = \pi (1 - \lambda) p x. \quad (2)$$

² See de Meza (1983) for an analysis of the ex post income effects of health insurance.

³ Linear contracts allow for a simple treatment of the moral hazard problem. More sophisticated contracts, as discussed, for example, by Spence and Zeckhauser (1971) and Blomqvist (1997), would not alter the character of the results derived in this paper since more complicated contracts are also unable to completely eliminate moral hazard behavior.

Drugs are supplied by a monopolist. We assume that the monopolist produces drugs at constant marginal costs c . Furthermore, the monopolist may incur fixed costs amounting to f . The monopolist's profit m can then be written as:

$$m = \pi (p - c) x - f. \quad (3)$$

Interaction in and between the drug and insurance markets can be described as a sequential game with a sequence of events as illustrated in Figure 1. In the first stage of the game, individuals choose an insurance contract given by the bundle (z, λ) . In the second stage, the monopolist chooses a price for the drug. In the third stage, nature decides which individuals become sick and which individuals stay healthy. Finally, in the fourth stage, individuals choose the drug quantity.

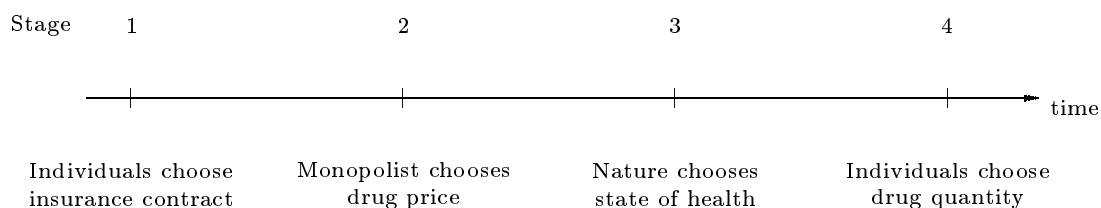


Figure 1. Sequence of Events

Note that because of the large number of individuals, the single individual's insurance choice has no influence on the pricing decision of the monopolist. Consequently, all results derived below would not change, if we considered a sequence of events implying that the individuals and the monopolist move simultaneously in the first stage. In contrast, if the monopolist sets the drug price before the individuals undertake their insurance decision, the monopolist has the opportunity to strategically influence the individuals' insurance decision. However, even in this case our results can be expected to hold if the model is reformulated with respect to the number of possible illnesses. To make this point more precise, suppose that there is not only one but that there are several types of illness. Each type of illness gives rise to a loss function of the form specified above. Furthermore, suppose that each type of illness can be treated with one particular drug. Then, when each supplier sets her price in the first stage and consumers buy insurance which pays a fixed portion of the costs of whatever drug consumed in the second stage, each supplier will take insurance choices as given, if she only has a small

share of the entire drug market.

3. The Market Equilibrium

The equilibrium in the insurance and in the drug market will be determined by backward induction. To start with, the quantity of drugs demanded by the representative individual in the last stage of the game is derived. Considering equation (1), a healthy individual will not consume any drugs, whereas a sick individual solves the following optimization problem:

$$\max_{x \geq 0} u[y - z - l(x) - \lambda p x],$$

where z , λ and p are predetermined by decisions made in previous stages. Assuming the disposable income y to be sufficiently high, the first order condition is given by:

$$-l'(x) - \lambda p = 0. \tag{4}$$

When sick, the individual extends drug demand to the point where the marginal reduction of the monetary loss achieved by extra drug consumption equals the marginal personal costs of drugs. Employing the implicit function theorem, one can infer that equation (4) implies a demand function of the form $x = x(p, \lambda)$ satisfying:

$$x_\lambda = -\frac{p}{l''} < 0, \tag{5a}$$

$$x_p = -\frac{\lambda}{l''} < 0, \tag{5b}$$

where x_λ and x_p are the partial derivatives of the demand function x with respect to λ and p . Since there are no ex post income effects of a price change on drug demand, x negatively depends on both the drug price p and the coinsurance rate λ .

In the second stage of the game, the monopolist chooses the profit maximizing drug price. Doing this, the monopolist takes individual drug demand as implicitly

defined by equation (4) into account. The monopolist thus solves:

$$\max_p \pi (p - c) x(\lambda, p) - f.$$

As the coinsurance rate λ is already fixed when the monopolist chooses the drug price, the first order condition for maximum monopoly profit is given by:

$$(p - c) x_p + x = 0, \tag{6}$$

where it is assumed that the profit maximizing price is strictly positive for all $c \geq 0$. Equation (6) implicitly defines the profit maximizing price p as a function of the coinsurance rate λ . Implicit differentiation yields:

$$\frac{dp}{d\lambda} = -\frac{(p - c) x_{\lambda p} + x_{\lambda}}{(p - c) x_{pp} + 2 x_p}. \tag{7}$$

Considering the second order condition for a profit maximum of the monopolist, the denominator of the right hand side of equation (7) is negative. In contrast, the sign of the numerator cannot be determined unambiguously without further restrictions. As the following lemma states, the sign of the numerator and, henceforth, the sign of $dp/d\lambda$ is unique when marginal costs are rather low.

Lemma 1.

- (i) $\frac{dp}{d\lambda} \geq -\frac{p}{\lambda}$, with = iff $c = 0$.
- (ii) There is some $\bar{c} > 0$ so that $dp/d\lambda < 0$ for all $c \in [0, \bar{c})$.

Proof: See the Appendix

To get an intuition of these results, consider how the quantity of drugs x depends on the coinsurance rate λ . Equations (5a,b) and (6) implicitly define x as a function $x = x(\lambda, p(\lambda))$. The total effect of an increase in λ on x reads $dx/d\lambda = x_{\lambda} + x_p (dp/d\lambda)$. As equations (5a,b) imply that $x_{\lambda} = x_p p/\lambda$, one gets $dx/d\lambda = x_p [(p/\lambda) + (dp/d\lambda)]$. Since $x_p < 0$, it follows from Lemma 1 that $dx/d\lambda \leq 0$ with = if $c = 0$. Thus, if $c = 0$ moral hazard of the insured does not lead to higher drug consumption. An increase in the coinsurance rate leads to a decrease in the demand for drugs for a given drug price. Facing this decrease in demand, the monopolist can generally adjust both price and quantity. If marginal

costs of drug production are equal to zero, the monopolist gains nothing by simply reducing the quantity. This does not lower her costs, it only lowers her revenue. Therefore, it will be more effective for her to reduce the price. If marginal costs are positive but small, a similar reasoning holds true, since for small marginal costs a quantity reduction has only a minor effect on total costs. It should be noted, however, that low marginal costs in drug production are only sufficient for $dp/d\lambda$ to be negative. If we assumed that $x_{\lambda p} \leq 0$, i.e. that the negative impact of an increase in the drug price on drug demand becomes (weakly) stronger for a higher coinsurance rate, then $dp/d\lambda$ would be strictly negative irrespective of the absolute degree of marginal costs c .⁴

We now move to the first stage of the game. In the first stage the representative individual chooses out of the set of all fair insurance contracts the one that maximizes his expected utility. Doing this, the individual takes into account his demand for drugs in case of illness as implicitly defined by equation (4). Because of the large number of individuals, however, the choice of insurance of a single individual does not influence the pricing decision of the monopolist. Consequently, the single individual takes the drug price as fixed. Therefore, the optimization problem in the first stage can be written as:

$$\begin{aligned} \max_{0 \leq \lambda \leq 1} \{ & \pi u[y - \pi(1 - \lambda)px(\lambda, p) - l(x(\lambda, p)) - \lambda px(\lambda, p)] \\ & + (1 - \pi)u[y - \pi(1 - \lambda)px(\lambda, p)] \}, \end{aligned}$$

given the drug price p . The first order condition reads:

$$\begin{aligned} -(1 - \pi)x(u'_s - u'_h) - (1 - \lambda)x_\lambda[\pi u'_s + (1 - \pi)u'_h] & \geq 0, \\ \text{with } & = 0, \text{ if } \lambda < 1, \end{aligned} \tag{8}$$

where u'_s and u'_h denote marginal utility in case of sickness and health, respectively. Condition (8) describes the trade-off between additional utility resulting from re-

⁴ Yet, the assumption of low marginal costs can be justified on the basis of plausibility considerations. The major part of the costs a drug producer incurs arises during the phase of developing the drug. For instance, the development of a drug until its introduction into the market lasts 12 to 15 years on average and the probability that a particular synthesized substance in fact leads to a marketable drug is about 0.01%. On the other hand, once a marketable drug has been developed, the costs of extra units are insignificant [see Bartling and Hadamit (1982), Walker and Parrish (1988), and Weisbrod (1991)].

duced risk and additional utility resulting from a lower insurance premium. It is easy to show that the representative individual chooses a strictly positive amount of insurance, i.e. that he chooses a coinsurance rate which is strictly smaller than one. For suppose, on the contrary, that the individual chooses a coinsurance rate equal to one. Then the first term of the left hand side of condition (8) is negative, because in the absence of insurance marginal utility in case of illness is larger than in case of health. The second term, on the other hand, is equal to zero if the coinsurance rate equals one. Thus, the sum of both terms is negative which is a contradiction to condition (8). Consequently, the coinsurance rate chosen by the individual, denoted as $\hat{\lambda}$, satisfies $\hat{\lambda} < 1$.⁵ The market equilibrium is then characterized by the insurance contract $(\hat{\lambda}, z(\hat{\lambda}))$, the drug price $p(\hat{\lambda})$, and the quantity of drugs $x(\hat{\lambda}, p(\hat{\lambda}))$.

4. Welfare Analysis

In this section we analyze how an increase in the coinsurance rate λ starting from its market equilibrium level $\hat{\lambda}$ affects consumer and social welfare. The concept of consumer welfare confines attention to the wellbeing of the individuals, whereas the concept of social welfare includes the welfare effects of a change in the monopoly profit.

4.a Consumer Welfare

In order to show that consumer welfare is not maximized in the market economy, we examine how a marginal change in the coinsurance rate will effect the individual's expected utility when λ equals $\hat{\lambda}$. Differentiation of (1) while considering (2) and (8) yields:

$$\frac{dEu}{d\lambda}\Big|_{\lambda=\hat{\lambda}} = -\pi(1-\hat{\lambda})(x+px_p)[\pi u'_s + (1-\pi)u'_h] \frac{dp}{d\lambda} - \pi\hat{\lambda}x u'_s \frac{dp}{d\lambda}. \quad (9)$$

A marginal change of the individually chosen coinsurance rate influences the wel-

⁵ A similar result is derived in Zeckhauser (1970), Blomqvist (1991), and Chiu (1997).

fare of the representative individual via price but not via quantity effects. When choosing the insurance contract, the individual takes the moral hazard effect on his drug demand into account, but he has no incentive to internalize the concomitant effect on the drug price. Equation (9) shows that the price effect influences consumer welfare in two ways. It affects expected utility by altering the insurance premium [first term on the right hand side of equation (9)] and by altering the personal share of drug expenses in case of illness [second term on the right hand side of equation (9)]. Generally, these two effects point in opposite directions as an increase in the coinsurance rate *ceteris paribus* leads to a lower insurance premium but higher out-of-pocket drug expenses. Still, the overall effect of an increase in the coinsurance rate can be unambiguously determined as equation (9) reduces to [see the Appendix for analytical details]:

$$\frac{dEu}{d\lambda}\Big|_{\lambda=\hat{\lambda}} = -[\pi u'_s + (1 - \pi) u'_h] \pi x \frac{dp}{d\lambda}. \quad (10)$$

The individual's overall ex ante drug expenses (including the expenses for insurance against the risk of drug expenses) are given by $\pi p x$. The term $\pi x dp$ thus measures the increase in overall drug expenses due to a marginal increase in the drug price. The term $[\pi u'_s + (1 - \pi) u'_h]$, on the other hand, measures ex ante marginal utility individuals derive from an extra unit of income. Hence, equation (10) states that the change in consumer welfare due to an increase in the coinsurance rate equals ex ante marginal utility individuals derive from a change in overall drug expenses due to a coinsurance rate induced change in the drug price. These expenses will decrease if the effect of an increase in the coinsurance rate on the price is negative. From Lemma 1 we know that $dp/d\lambda < 0$ holds true if the marginal costs of drug production are sufficiently low ($c < \bar{c}$). Thus, we get the following result.

Proposition 1. A marginal increase in the coinsurance rate λ starting from the market equilibrium level $\hat{\lambda}$ raises consumer welfare for all $c \in [0, \bar{c})$.

Proposition 1 implies that rationing in the insurance market would benefit consumers and, thus, extends the findings of Feldstein (1973) and others to the case of monopolistic supply in medical goods markets. As has been pointed out by Feldstein (1973, fn. 3), consumers are in a situation that resembles the prisoner's dilemma. All consumers would be better off if coinsurance rates were higher, but each single consumer has an incentive to purchase more insurance than would be

optimal in terms of consumer welfare.

4.b *Social Welfare*

An increase in the coinsurance rate benefits consumers, but it is also likely to harm the drug producer by lowering the monopoly profit. In order to evaluate an increase in the coinsurance rate in terms of social welfare, the effect on the monopoly profit must be explicitly taken into account. We do this by distributing the monopoly profit in a lump sum manner to the individuals, i.e. we add the monopoly profit to individual income. Ex ante social welfare can then be expressed in terms of individual expected utility as follows:

$$Ev = \pi u(y + m - z - l - \lambda px) + (1 - \pi) u(y + m - z). \quad (11)$$

In order to avoid that the monopoly profit exerts an ex ante income effect on the individuals' insurance choice, we shall impose a further restriction on the utility function u . We assume that:

$$-u''(\xi)/u'(\xi) = \text{constant for all } \xi \geq 0,$$

which means that individuals have constant absolute risk aversion. This assumption guarantees that in the market equilibrium the individuals will choose the coinsurance $\hat{\lambda}$ irrespective of the size of the monopoly profit m .

Analogous to the analysis in sub-section 4.a we can examine how a marginal increase in the coinsurance rate affects social welfare in the market equilibrium. Differentiating (11) with respect to λ and then proceeding in the same way as in sub-section 4.a we find that:

$$\frac{dEv}{d\lambda}\Big|_{\lambda=\hat{\lambda}} = \frac{dEu}{d\lambda}\Big|_{\lambda=\hat{\lambda}} + [\pi u'_s + (1 - \pi) u'_h] \frac{dm}{d\lambda}\Big|_{\lambda=\hat{\lambda}}. \quad (12)$$

Since we assume constant absolute risk aversion, the first term on the right hand side of (12) is identical to (10) if one replaces y by $y + m$. It measures the effect of an increase in λ on social welfare via a change in consumer welfare. In sub-section 4.a we have demonstrated that the change in consumer welfare is given by ex ante marginal utility individuals derive from reduced overall ex ante drug expenses. The second term on the right hand side of (12) measures the effect on social welfare via

a change in the monopoly profit. It consists of ex ante marginal utility individuals derive from extra income in the form of a coinsurance rate induced change in the monopoly profit. This change can be determined by differentiating (3) with respect to λ while considering the envelope theorem:

$$\frac{dm}{d\lambda} = \pi (p - c) x_{\lambda}.$$

As expected, an increase in λ negatively affects the monopoly profit (recall that $x_{\lambda} < 0$) so that the monopoly profit effect lowers social welfare. Employing equations (5a,b) and (6), x_{λ} can be replaced by $-p x / [\lambda (p - c)]$ and the change in the monopoly profit becomes $dm/d\lambda = -\pi p x / \lambda$. Considering (10), the social welfare effect of a marginal increase in the coinsurance rate can then be written as:

$$\frac{dEv}{d\lambda} \Big|_{\lambda=\hat{\lambda}} = -[\pi u'_s + (1 - \pi) u'_h] \pi x \left(\frac{dp}{d\lambda} + \frac{p}{\lambda} \right).$$

This expression reveals that the social welfare effect of an increase in the coinsurance rate consists of ex ante marginal utility due to extra money in terms of reduced overall drug expenses versus ex ante marginal utility due to foregone money in terms of reduced monopoly profits. In light of Lemma 1 the monopoly profit effect just neutralizes the drug expense effect if $c = 0$ and strictly dominates it if $c > 0$. Proposition 2 summarizes this result.

Proposition 2. A marginal increase in the coinsurance rate λ starting from the market equilibrium level $\hat{\lambda}$ leaves social welfare unaffected if $c = 0$ and lowers social welfare if $c > 0$.

In section 3 we have shown that the equilibrium quantity of drug consumption is not affected by an increase in the coinsurance rate if marginal costs of drug production are zero. In this case individuals gain in terms of reduced overall ex ante drug expenses what they lose in terms of monopoly profits if the coinsurance rate is increased. As a consequence, there is no effect of reduced insurance coverage on social welfare. In contrast, if marginal costs in the drug industry are strictly positive, an increase in the coinsurance rate lowers equilibrium drug consumption. In this case the welfare loss from lower monopoly profits more than outweighs the welfare gain from reduced overall ex ante drug expenses. Proposition 2 essentially says that the distortion on drug consumption due to deficient monopolistic supply dominates the distortion that is associated with moral hazard and the concomitant

price increasing effect of excess drug consumption.⁶ Therefore, a gain in social welfare is possible by increasing insurance coverage against drug expenses beyond the amount individuals choose to purchase in the market.

5. Conclusion

In this paper we have shown that health insurance against the risk of drug expenses as purchased by individuals in competitive insurance markets is neither second best in terms of consumer nor in terms of social welfare when drugs are supplied by a monopolist.

Monopoly power in drug markets can be attributed to patent protection which is a common measure to induce private firms to meet the enormous costs of developing drugs. In fact, drug producers protected by patents account for a significant share of drug markets in all developed countries. In Germany, for instance, patent protected drugs that have been introduced since 1985 reached a revenue of 8.4 billion deutschmarks in 1998 which means a share of 24% of the entire German drug market [see Schröder and Selke (2000)]. It could be argued that patent protection for drugs does not necessarily lead to considerable market power as for most patented drugs substitutes are available. Yet, what drives our result is that there is some scope for setting prices above marginal costs so that the result can be expected to hold in those cases where substitutes are not very close. Moreover, even pure monopolies can be found in drug markets as, for instance, the drug for erectile dysfunction *Viagra*. For this drug no veritable substitute exists.

⁶ Note that an increase in the coinsurance rate λ increases the drug price p . Therefore, Proposition 2 seems to contradict the result by Gaynor et al. (2000) who showed that a decrease in the price for medical goods increases social welfare for prices larger than marginal costs if the insurance market is competitive. However, it is straightforward to show that in case of constant absolute risk aversion the response of the market equilibrium coinsurance rate $\hat{\lambda}$ as implicitly defined by (8) on an exogenous increase in the drug price p satisfies $d\hat{\lambda}/dp > -\hat{\lambda}/p$. It follows that an increase in p also increases the price for the drug faced by the consumers, λp , so that drug demand decreases. The same is true when the price p is determined by a monopolist and λ is increased. Because of $dp/d\lambda > -p/\lambda$ for $c > 0$, an increase in λ , although reducing the drug price p , increases the net price λp so that again drug consumption decreases.

Gaynor and Haas-Wilson (1999) as well as Gaynor et al. (2000) argued that restricting the potential to raise prices above marginal costs in medical goods markets may contribute to increase consumer as well as social welfare. Our analysis points to an alternative welfare enhancing strategy. It becomes relevant when market power due to patent protection is a necessary evil in order to give proper incentives to innovate. The policy strategy that can be deduced from our analysis depends on whether consumer or social welfare is the relevant policy target. Consumer welfare would be higher if health insurance were rationed relative to the market outcome. In contrast, social welfare would be higher if health insurance were extended beyond the level individuals choose to purchase in the market.

Appendix

Proof of Lemma 1

Rewrite equation (7) as $dp/d\lambda = N/D$, with:

$$N = -(p - c) x_{\lambda p} - x_{\lambda},$$

$$D = (p - c) x_{pp} + 2 x_p.$$

Differentiation of (5a,b) reveals that:

$$x_{pp} = -\frac{\lambda^2 l'''}{l''^3} = x_{\lambda p} \frac{\lambda}{p} - \frac{1}{p} x_p.$$

Substituting for x_{pp} in the expression for D , replacing x_p by $\lambda x_{\lambda}/p$ which follows from (5a,b), and then solving for $-(p - c) x_{\lambda p}$ yields:

$$-(p - c) x_{\lambda p} = -\frac{p}{\lambda} D + \left(1 + \frac{c}{p}\right) x_{\lambda}.$$

Substituting for $-(p - c) x_{\lambda p}$ in the expression for N gives:

$$N = -\frac{p}{\lambda} D + \frac{c}{p} x_{\lambda}$$

so that:

$$\frac{dp}{d\lambda} = -\frac{p}{\lambda} + \frac{c}{p} \frac{x_{\lambda}}{D}.$$

Since p is the profit maximizing price of the monopolist, the respective second order condition implies $D < 0$. Furthermore, since by assumption, p is strictly positive for $c = 0$, drug demand x is finite for all $c \geq 0$ so that Lemma 1 follows with a standard continuity argument. *Q.E.D.*

Derivation of Equation (10)

Considering (6), $x + p x_p$ can be translated into $-c x/(p - c)$ so that (9)

becomes:

$$\frac{dEu}{d\lambda}\Big|_{\lambda=\hat{\lambda}} = \left[\pi (1 - \hat{\lambda}) \frac{cx}{p-c} [\pi u'_s + (1 - \pi) u'_h] - \pi \hat{\lambda} x u'_s \right] \frac{dp}{d\lambda}.$$

This is equivalent to:

$$\begin{aligned} \frac{dEu}{d\lambda}\Big|_{\lambda=\hat{\lambda}} = & \left[\pi (1 - \hat{\lambda}) \frac{cx}{p-c} [\pi u'_s + (1 - \pi) u'_h] - \pi \hat{\lambda} x u'_s \right. \\ & \left. + \pi x [\pi u'_s + (1 - \pi) u'_h] \right] \frac{dp}{d\lambda} - \pi x [\pi u'_s + (1 - \pi) u'_h] \frac{dp}{d\lambda}. \end{aligned}$$

Straightforward manipulation of the term in square brackets leads to:

$$\begin{aligned} \frac{dEu}{d\lambda}\Big|_{\lambda=\hat{\lambda}} = & \frac{\pi x}{p-c} \left[(p - \hat{\lambda}c) [\pi u'_s + (1 - \pi) u'_h] - \hat{\lambda}(p-c) u'_s \right] \frac{dp}{d\lambda} \\ & - \pi x [\pi u'_s + (1 - \pi) u'_h] \frac{dp}{d\lambda}. \end{aligned}$$

Now consider the individually chosen coinsurance rate $\hat{\lambda}$ as implicitly determined by (8). Making use of the fact that $x_\lambda = -px/[\lambda(p-c)]$, which follows from (5a,b) and (6), (8) can be transformed into:

$$(p - \hat{\lambda}c) [\pi u'_s + (1 - \pi) u'_h] = \hat{\lambda}(p-c) u'_s$$

so that the expression for $(dEu/d\lambda)|_{\lambda=\hat{\lambda}}$ reduces to (10).

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