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Are Invisible Hands Good Hands in Health Care Markets? Extension

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Abstract: A previous study finds that increased competition in health care markets improves social welfare, although consumers use "too much" health care when they have health insurance. The analysis assumes that consumers have a constant *Arrow-Pratt coefficient of absolute risk aversion*. This note shows that this finding can be extended to the case where consumers are simply risk averse. Furthermore, if insurers offered insurance policies with slightly lower usage prices than the equilibrium level, social welfare would be improved.

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1 Introduction

In the health economics literature, it is often suggested that particular distortions in health care markets imply that competition may not be socially desirable (Crew 1969). Health insurance often leads to out-of-pocket usage prices that are less than the marginal costs of medical services. Health insurance thus generates deadweight loss by encouraging too much consumption of the services. Therefore, reducing competition would raise usage prices that are "too low," and thus may be desirable. Gaynor, Hass-Wilson, and Vogt (GHV) argue that this view cannot be correct if insurance markets are competitive or monopolistic. They find that "*provided that price exceeds marginal cost in the medical market, the benefit to consumers of a price decrease outweighs the loss in profits suffered by the medical industry*" (GHV 2000, 1001).

GHV's (2000) finding has important policy implications in health care regulation. However, the analysis is based on a specific exponential Bernoulli utility function,[1] $v(x) = -\exp(-rx)$ (GHV 2000, 999), which means that

1 The terminology "Bernoulli utility function" follows Mas-Colell et al. (1995, 184).

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consumers have a constant *Arrow-Pratt coefficient of absolute risk aversion* $r>0$. It is unclear whether this assumption can easily be satisfied in the real world. The present note shows that the model can be extended to one with a general concave Bernoulli utility function, which means that the finding remains valid as long as consumers are risk averse.

In a related paper, Wigger and Anlauf (2007) study the role of market power in health care markets. They consider a market with a monopolistic drug provider and competitive insurers. Consumers are either healthy or sick. In the latter case, they have demands for drugs. Consumers choose an insurance contract (characterized by a premium and a co-insurance rate) before the monopolist chooses a drug price. Wigger and Anlauf show that when the marginal cost of the drug is strictly positive, a marginal increase in the co-insurance rate, starting from the market equilibrium level, lowers social welfare. The present note shows that a marginal increase in the out-of-pocket usage price from the equilibrium level always reduces social welfare. The findings are in contrast to the view of Crew (1969).

2 Model

Consider a standard insurance model. There is a continuum of consumers who are homogeneous *ex ante*. They face independent health shocks. Each consumer has the following utility function:

$$U(Y-\tau x-m,x,\varepsilon)=v(Y-\tau x-m+g(x,\varepsilon)), \qquad [1]$$

$$g_1>0, g_{11}<0, g_2<0, g_{12}>0. \qquad [2]$$

In expression [1], $v(\cdot)$ is the Bernoulli utility function, defined on the *ex post* monetary payoff of the consumer, Y is the consumer's income, τ is the out-of-pocket usage price faced by an insured consumer, m is the insurance premium, x is the quantity of health care consumed, ε is a random shock to health, and $g(x,\varepsilon)$ is the consumer's *ex post* benefit from health care. GHV (2000, 999) assume that the Bernoulli utility function is $v(b)=-\exp(-rb)$, in order to "*guarantee that there are no income effects ex ante*." In this note, function $v(.)$ can be any differentiable function on $[0,+\infty)$ that satisfies $v'(\cdot)>0$ and $v''(\cdot)<0$. The health care market is imperfectly competitive and the insurance market is perfectly competitive. The market price and marginal cost of health care are denoted by p and c, respectively.

The game played in the market has the following timing. First, health care providers interact and determine the market price of health care. Second, insurance firms offer insurance policies. Third, consumers decide to accept or refuse the policies. Fourth, health states are realized and consumers choose their quantity demanded of health care. As in GHV (2000), the interaction among health care providers is not explicitly modeled here. A lower market price represents more intensive competition in the health care market.

3 Invisible hands are good hands

The model is solved through backward induction. Conditional on insurance policy (τ, m) being accepted by a consumer at the *third* stage, the consumer in state ε maximizes her *ex post* utility $v(Y - \tau x - m + g(x, \varepsilon))$ at the *fourth* stage. Because $v'(\cdot) > 0$, she only needs to maximize her *ex post* payoff $(Y - \tau x - m + g(x, \varepsilon))$. Hence the consumer solves the following problem at the *fourth* stage.

$$\underset{x \geq 0}{Max} \;\; b(x, \varepsilon) \equiv Y - \tau x - m + g(x, \varepsilon). \tag{3}$$

The demand for health care x^* satisfies the first-order condition

$$g_1(x^*, \varepsilon) = \tau \text{ when } x^* > 0. \tag{4}$$

Hence, the consumer's *ex post* demand for health care $x^* = x^*(\tau, \varepsilon)$ depends on the out-of-pocket price τ, but not on the insurance premium m. We have $x^* = 0$ if and only if $\tau \geq g_1(0, \varepsilon)$. When there is a non-degenerated solution, from eq. [4] we have

$$\frac{\partial x^*(\tau, \varepsilon)}{\partial \tau} = \frac{1}{g_{11}} < 0 \tag{5}$$

and

$$\frac{\partial x^*(\tau, \varepsilon)}{\partial \varepsilon} = -\frac{g_{12}}{g_{11}} > 0. \tag{6}$$

The Envelop Theorem implies that

$$\frac{\partial b(x, \varepsilon)}{\partial \varepsilon} = g_2(x, \varepsilon) < 0. \tag{7}$$

At the *second* stage, the insurance firms offer the most attractive policy that is not money-losing. Given health care price p, the insurers solve the following problem:

$$\underset{\tau, m}{Max} \;\; E[v(Y - \tau x^* - m + g(x^*, \varepsilon))], \tag{8}$$

$$s.t., m-(p-\tau)E(x^*)\geq 0. \tag{9}$$

Constraint [9] must be binding because of competition. The problem can be rewritten as an unconstrained problem

$$\underset{\tau}{Max}\ \ L(\tau;p)\equiv E[v(Y-\tau x^*-(p-\tau)E(x^*)+g(x^*,\varepsilon))], \tag{10}$$

where $x^*=x^*(\tau,\varepsilon)$ is given by eq. [4]. For any $p\geq c$, it is assumed that the objective function is continuous and differentiable.

If problem [8] or [10] has multiple (or a compact set of) solutions, we shall assumed that the insurers always choose the solution that has the lowest usage price (and the highest premium). Indeed, while the consumers and insurers are indifferent to any of the solutions, the health care providers strictly prefer the solution with the lowest usage price, which induces the highest consumption of health care. Hence, there is a unique Pareto optimal policy. Such a policy is written as $(\tau(p),m(p))$. Given health care price p, function $L(\tau;p)$ is strictly increasing in a small-enough left-neighborhood of $\tau(p)$, and non-increasing in a small-enough right-neighborhood of $\tau(p)$.

Lemma 1: *Given health care price p, an optimal insurance policy satisfies* $\tau(p)<p$.

Proof: The solution of problem [10] satisfies the following first-order condition:

$$\begin{aligned}
L_1(\tau;p) &= E\left[v'(b)\left(-x^*-\tau\frac{\partial x^*}{\partial\tau}+E(x^*)-(p-\tau)E\left(\frac{\partial x^*}{\partial\tau}\right)+g_1(x^*,\varepsilon)\frac{\partial x^*}{\partial\tau}\right)\right]\\
&= E[v'(b)(-x^*+E(x^*)]-(p-\tau)E\left(\frac{\partial x^*}{\partial\tau}\right)E(v'(b)) \quad [\text{Note that } g_1(x^*,\varepsilon)=\tau] \qquad [11]\\
&= -Cov(v'(b),x^*)+(\tau-p)E\left(\frac{\partial x^*}{\partial\tau}\right)E(v'(b))=0.
\end{aligned}$$

Since $v'(\cdot)$ is decreasing, from eqs [6] and [7] we have both $v'(b)$ and x^* strictly increasing with ε. Thus, $Cov(v'(b),x^*)>0$.[2] We also have $E(\frac{\partial x^*}{\partial\tau})=E(\frac{1}{g_{11}})<0$ and $E(v'(b))>0$. Hence, eq. [11] implies that $\tau<p$ in equilibrium.[3] *Q.E.D.*

The insurance makes health care providers better off by increasing consumer demand for health care. The insurance also makes consumers better off by (partially) insuring them from health shocks. Therefore, insurers bring a Pareto improvement to society.

2 See Schmidt (2003) for the details of the mathematics.

3 It is easy to see from eq. [11] that we would have $\tau(p)=p$ if the consumer is risk-neutral.

When the health care market is highly competitive, it is likely that health insurance generates *ex post* deadweight loss. For example, if $p = c$, then usage price $\tau < c$, which leads to the so-called "moral hazard" problem in the health economics literature (Crew 1969). As GHV (2000, 996) mention, "*ex post efficiency is not a sensible welfare criterion here since it ignores the benefits to obtaining insurance ex ante*." Assume that function $\tau(\cdot)$ is continuously differentiable. We have the following lemma.

Lemma 2: *Usage price $\tau(p)$ is non-decreasing.*

Proof: First we note that $L(\tau;p)$ as a function of τ is concave around $\tau = \tau(p)$. If $\tau(p)$ is not non-decreasing, there exists a $\tilde{p}$ and a "small enough" $\xi > 0$ such that $\tau(\cdot)$ is strictly decreasing in the interval $(\tilde{p}, \tilde{p} + \xi)$. Since $\tau(\tilde{p} + \xi)$ maximizes $L(\tau;\tilde{p} + \xi)$, $L(\tau;\tilde{p} + \xi)$ as a function of τ must be non-increasing in the "small enough" interval $(\tau(\tilde{p} + \xi), \tau(\tilde{p}))$. Hence, we have

$$L_1(\tau;\tilde{p} + \xi)|_{\tau = \tau(\tilde{p})} \leq 0. \qquad [12]$$

However, with eq. [11],

$$\begin{aligned} L_1(\tau;\tilde{p} + \xi)|_{\tau = \tau(\tilde{p})} &= -Cov(v'(b), x^*(\tau, \varepsilon)) + (\tau(\tilde{p}) - \tilde{p} - \xi)E\left(\frac{\partial x^*(\tau, \varepsilon)}{\partial \tau}\right)E(v'(b)) \\ &= \left[-Cov(v'(b), x^*) + (\tau(\tilde{p}) - \tilde{p})E\left(\frac{\partial x^*}{\partial \tau}\right)E(v'(b))\right] - \xi E\left(\frac{\partial x^*}{\partial \tau}\right)E(v'(b)) \\ &= -\xi E\left(\frac{\partial x^*}{\partial \tau}\right)E(v'(b)) > 0. \end{aligned} \qquad [13]$$

This conflicts with eq. [12]. Hence, $\tau(p)$ must be non-decreasing. *Q.E.D.*

The *per capita* health care industry's expected profit is $\pi_m = (p - c)E(x^*)$. As GHV (2000), I add the *per capita* profits to the consumer's income in order to conduct a social welfare analysis. The expected social welfare (*per capita*) is then represented by

$$W(p) = E[v(Y + \pi_m - \tau x^* - m + g(x^*, \varepsilon))]. \qquad [14]$$

Note that the consumer is only a representative of many consumers. She is unable to noticeably influence the *per capita* profits by adjusting her health care consumption. Hence she takes the *per capita* profits as exogenously given. Because of the separability inside $v(.)$, the consumers' *ex post* maximization problem still leads to $x^* = x^*(\tau, \varepsilon))$ as shown in problem [3]. In other words, receiving π_m would not affect the consumers' demands for health care. With $\pi_m(p) = (p - c)E(x^*)$, $m = (p - \tau)E(x^*)$, $x^* = x^*(\tau, \varepsilon))$ and $\tau = \tau(p)$,

$$\begin{aligned}W(p) &= E[v(Y+(p-c)E(x^*(\tau(p),\varepsilon))-\tau(p)x^*(\tau(p),\varepsilon)\\&\quad -(p-\tau(p))E(x^*(\tau(p),\varepsilon))+g(x^*(\tau(p),\varepsilon),\varepsilon))]\\&= E[v(Y+(\tau(p)-c)E(x^*(\tau(p),\varepsilon))-\tau(p)x^*(\tau(p),\varepsilon)\\&\quad +g(x^*(\tau(p),\varepsilon),\varepsilon))].\end{aligned} \tag{15}$$

Corresponding to Proposition 2 of GHV (2000), the following result implies that social welfare $W(p)$ is maximized at $p=c$.

Proposition 1: *Expected social welfare $W(p)$ is non-increasing on $[c, +\infty)$.*

Proof: Let $b \equiv Y+(\tau-c)E(x^*(\tau,\varepsilon))-\tau x^*(\tau,\varepsilon)+g(x^*(\tau,\varepsilon),\varepsilon)$. From eq. [15],

$$\begin{aligned}W'(p) &= E\left[v'(b)(\tau'(p)E(x^*)+(\tau-c)E\left(\frac{\partial x^*}{\partial p}\right)-\tau'(p)x^*-\tau\frac{\partial x^*}{\partial p}+g_1(x^*,\varepsilon)\frac{\partial x^*}{\partial p})\right]\\&= E\left[v'(b)(\tau'(p)(E(x^*)-x^*)+(\tau-c)E\left(\frac{\partial x^*}{\partial p}\right))\right]\\&= \tau'(p)E[v'(b)(E(x^*)-x^*)]+(\tau-c)E\left(\frac{\partial x^*}{\partial \tau}\tau'(p)\right)E[v'(b)]\\&= -\tau'(p)Cov(v'(b),x^*)+\tau'(p)(\tau-c)E\left(\frac{\partial x^*}{\partial \tau}\right)E[v'(b)]\end{aligned} \tag{16}$$

The insurance policy is endogenous. From eq. [11],[4]

$$Cov(v'(b),x^*) = -(p-\tau)E\left(\frac{\partial x^*}{\partial \tau}\right)E(v'(b)). \tag{17}$$

Substituting into eq. [16],

$$\begin{aligned}W'(p) &= \tau'(p)(p-\tau)E\left(\frac{\partial x^*}{\partial \tau}\right)E[v'(b)]+\tau'(p)(\tau-c)E\left(\frac{\partial x^*}{\partial \tau}\right)E[v'(b)]\\&= \tau'(p)(p-c)E\left(\frac{\partial x^*}{\partial \tau}\right)E[v'(b)]\end{aligned} \tag{18}$$

Since $\tau'(p)\geq 0$, $p>c$, $E(\frac{\partial x^*}{\partial \tau})<0$, and $E[v'(b)]>0$, we have $W'(p)\leq 0$. *Q.E.D.*

From eq. [15], it can be seen that the price of health care p influences (expected) social welfare through and only through the usage price $\tau(p)$, which is determined by problem

4 The "b" here slightly differs from that in eq. [11], because of the addition of *per capita* health care industry profits to consumer income. But since the consumer takes the *per capita* profits as given, eq. [17] still holds.

$$\underset{\tau}{Max}\ L(\tau;p) \equiv E[v(Y + \pi_m - \tau x^* - (p - \tau)E(x^*) + g(x^*, \varepsilon))] \qquad [19]$$

This problem differs from problem [10] only by the π_m inside $v(.)$. Since adding *per capita* profits π_m to the consumer's income does not affect the consumer's *ex post* demand $x^*(\tau, \varepsilon)$, the solutions to the two problems are the same. When insurers solve problem [19], they do not take into account the external effects on health care providers. Note that a lower usage price leads to higher provider profits. Hence the equilibrium usage price tends to be too high from the perspective of social welfare.

Proposition 2: *Given health care price $p > c$, if insurers offered a policy with a slightly lower usage price than the equilibrium level, social welfare would be improved.*

Proof: The socially optimal usage price is given by the following problem:

$$\underset{\tau}{Max}\ W(\tau) \equiv E[v(Y + \pi_m - \tau x^* - (p - \tau)E(x^*) + g(x^*, \varepsilon))], \qquad [20]$$

where $\pi_m = (p - c)E(x^*(\tau, \varepsilon))$ is decreasing in usage price τ, rather than exogenously given. Noting $g_1(x^*, \varepsilon) = \tau$, the first-order condition of the problem is

$$\begin{aligned}
\frac{\partial W}{\partial \tau} &= E\left[v'(b)(-x^* - \tau\frac{\partial x^*}{\partial \tau} + E(x^*) - (p - \tau)E\left(\frac{\partial x^*}{\partial \tau}\right) + g_1(x^*, \varepsilon)\frac{\partial x^*}{\partial \tau} + \frac{\partial \pi_m}{\partial \tau})\right] \\
&= E[v'(b)(-x^* + E(x^*)] - (p - \tau)E\left(\frac{\partial x^*}{\partial \tau}\right)E(v'(b)) + E\left[(v'(b)\frac{\partial \pi_m}{\partial \tau}\right] \qquad [21] \\
&= -Cov(v'(b), x^*) + (\tau - p)E\left(\frac{\partial x^*}{\partial \tau}\right)E(v'(b)) + E\left[(v'(b)\frac{\partial \pi_m}{\partial \tau}\right] = 0.
\end{aligned}$$

Since $v'(.) > 0$ and $\frac{\partial \pi_m}{\partial \tau} < 0$, $E[(v'(b)\frac{\partial \pi_m}{\partial \tau}] < 0$. Hence, at the market equilibrium usage price, which satisfies eq. [17], we have $\frac{\partial W}{\partial \tau} = E[(v'(b)\frac{\partial \pi_m}{\partial \tau}] < 0$. Therefore, if insurers offered a slightly lower usage price, social welfare would be improved. *Q.E.D.*

Proposition 2 resembles a finding in Wigger and Anlauf (2007), but the two models differ in the number of health states, modeling of insurance contracts, and timing of the games. Wigger and Anlauf assume two health states ("healthy" and "sick"), an insurance contract is characterized by a premium and a co-insurance rate, and consumers choose an insurance contract before the monopolistic drug provider chooses a price. GHV (2000) and the present note, instead, assume a continuum of health states. An insurance contract is characterized by a premium and an out-of-pocket usage price, and based on the given health care price. Wigger and Anlauf (2007) find that a marginal increase in the co-insurance rate, starting from the market equilibrium level, leaves social welfare unaffected if the marginal cost of the drug is zero, and lowers social welfare if the marginal cost is positive. The present note finds that a marginal increase in the out-of-pocket usage price from the equilibrium level always lowers social welfare, whether the marginal cost is zero or positive.

4 Conclusion

Gaynor et al. (2000) find that "invisible hands are good hands" in health care industries. As the authors suggest, their model ignores income effects on consumer choices: "*the separability inside (the Bernoulli utility function) v guarantees that there are no income effects ex post. The assumption of an exponential form for v guarantees that there are no income effects ex ante*" (GHV 2000, 999).

I show that the assumption of "*an exponential form for v*" is unnecessary, i. e., the findings hold as long as consumers are risk-averse. Whether the assumption of "*separability inside v*" can also be dropped calls for future study. I also show that if competitive insurance firms offered policies with slightly lower usage prices than the equilibrium level, social welfare would be improved.

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