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Article abstract

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The Impact of Health Care Cost Increases on Fraud and Economic Waste*

by Martin Boyer and Pierre-Thomas Léger

ABSTRACT

In a model of imperfect information with costly auditing, we examine the effect of increases in health-care costs and general inflation on the optimal health-insurance policy and on waste. We show that in such a setting, individuals will buy more than full insurance. Moreover, as the cost of medical care increases, consumers (i.e., patients) are less likely to file unjustified claims while insurance providers audit with a lower probability. As a result, waste associated with costly auditing is reduced. We also show that a general increase in the opportunity cost of illness (reflected through lost earnings due to illness) also decreases waste, but not as much as health-care cost increases

Keywords: Health care fraud, asymmetric information, contract theory.

RÉSUMÉ

Nous étudions l'impact d'une augmentation du coût des soins de santé et de l'inflation en général sur le contrat optimal d'assurance médicale et sur le gaspillage. Nous situons notre modèle dans une économie où les agents-consommateurs pos-

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sèdent une information privilégiée et où le principal-assureur doit encourrir des coûts d'audit pour vérifier l'information des agents. Nous montrons ainsi que les agents seront plus que pleinement assurés. De plus, une augmentation du coût des soins de santé réduit la probabilité que les agents demandent des soins de santé injustifés. En conséquence, le gaspillage associé aux audits onéreux diminue. Nous montrons finalement qu'une augmentation dans le coût de la vie en général (que nous mesurons au moyen par le revenu perdu à cause de la maladie) réduit également le gaspillage associé aux audits, mais dans une mesure moindre qu'une augmentation dans le coût des soins de santé.

Mots clés: Fraude médicale, information asymétrique, théorie des contrats.

I. INTRODUCTION

The dramatic increase in health-care spending in most OECD countries over the past half century (see Table 1 below) has attracted much attention from both the scientific and popular press. This is especially true in the United States, Belgium and Switzerland where the health-care share of gross domestic product (GDP) has more than doubled in the last 30 years.

TABLE I
TOTAL EXPENDITURE HEALTH – PERCENTAGE OF GROSS DOMESTIC PRODUCT

Year	Canada	France	Italy	Belgium	Japan	Switzer-land	U.K.	USA	Sweden
1970	7.0	5.4	5.2	4.0	4.5	5.4	4.5	6.9	6.9
1975	7.2	7.0	6.2	5.9	5.6		5.5	8.0	7.9
1980	7.1	7.1	7.0	6.4	6.5	7.3	5.6	8.7	9.1
1985	8.2	8.2	7.1	7.2	6.7	7.7	5.9	10.0	8.7
1990	9.0	8.6	8.0	7.4	5.9	8.3	6.0	11.9	8.4
1995	9.2	9.5	7.4	8.7	6.8	9.7	7.0	13.3	8.1
2000	8.9	9.3	8.1	8.8	7.6	10.4	7.3	13.1	8.4
2002	9.6	9.7	8.5	9.1	7.8	11.2	7.7	14.6	9.2

(Constructed using the *OECD Health Data 2004*)

Although economists are generally unconcerned with increases in a particular type of consumer spending as a percentage of GDP, increased spending on health care is likely to have welfare implications. This is because the market for health care is often plagued by information asymmetry, moral hazard and adverse selection. That is, insured individuals (who do not pay the full cost of medical services they receive) are likely to consume beyond the point where the marginal cost of care is equal to its marginal benefit (the well known moral-hazard problem). Furthermore, because patients, providers and insurers have different information, each group is likely to attempt to manipulate available information to maximize their own welfare to the detriment of the others'.[1] Thus, both insurance and information asymmetry can lead to important losses in aggregate welfare. As a result, much research has centered on the possible causes of this growth and potential means of reducing it.

Although the proliferation of insurance accounts for a portion of total health care spending increases, several other reasons have been put forth including: (i) the general increase in economic well-being (Newhouse, 1977; Blomqvist and Carter, 1997); (ii) increased competition in the physicians' market (McGuire and Pauly, 1991); (iii) the medical arms race (Dranove et al., 1992); (iv) the presence of labour unions and medical boards (Sloan and Adamache, 1984); (v) the proliferation of malpractice litigation; and (vi) increases in technology (Goddeeris 1984; Weisbrod, 1991). In turn, many have sought to examine the welfare loss associated with such causes.[2] Most studies, however, have generally neglected a potential benefit associated with high costs or greater spending on health care (besides greater health): that of a reduction in unnecessary procedures.

In the model presented below, we examine the case where patients lie about their illness to extract rents from their insurer. As a result, insurers may choose to verify a patients' illness claims through a costly audit. Because auditing is costly, yet yields no direct benefit to either patients or to insurers, it is, *ceteris paribus*, a resource loss. By including such auditing costs in a game between consumers and an insurer provider, we examine the effect of increased health-care costs (what we term *health-care-cost inflation*[3]) and *general inflation* on the optimal insurance contract as well as its effect on the welfare loss associated with auditing.

Several results are worth noting. First, unlike in traditional models, we show that patients are offered insurance contracts in which they are over-insured in the sense that their indemnity is larger than their potential loss. This result comes from the fact that, in a model of information asymmetry with auditing costs, insurers who cannot commit ex ante to an auditing strategy will "over-insure' their customers in order to increase their own incentive to audit (this is because potential losses associated with patient cheating are greater). Given that insurers have a greater incentive to monitor, patients in turn reduce their amount of false claims. As a result, patients receive a higher payoff when reporting an illness (both justified *or* unjustified without auditing) *but* the probability that patients file unjustified claims (i.e., commit fraud) decreases.

We also show that an increase in the cost of medical treatment (both through a direct increase in the price of medical care or, through increased losses due to lost earnings) leads to a decrease in economic waste associated with auditing. Thus, the potential welfare loss associated with higher medical-care costs may be over-estimated if decreases in wasteful auditing are neglected. Finally, we show that wasteful auditing is reduced more when the cost of medical care increases than when general inflation increases.

We augment the traditional health-insurance model in two ways. First, we imbed into the health-insurance coverage an implicit disability benefit that allows consumers to be compensated for lost earnings while receiving health-care services. Second, we focus on the demand side (as opposed to the supply side) of health-insurance services as an additional explanation for recent increases in spending.

The remainder of the paper will be organized as follows. In section 2 we introduce a principal-agent model with information asymmetry. In this section, we introduce a measure of waste associated with auditing and examine the effects of both general and health care inflation on waste. Conclusions are drawn in Section 3.

2. THE MODEL

In the following section, we introduce a simple game between a consumer and a unique provider-insurer.[4] In the model, risk-averse consumers have VonNeumann-Morgenstern utility functions over final wealth where $U'(.) > 0$, $U''(.) < 0$ and $U'(0) = \infty$. The insurer is risk neutral. There are only two states of nature: sick and healthy. The consumer is sick with probability $\pi < 1/2$. [5] If the consumer is sick, he must stop working and loses labor income w. If the consumer seeks care (whether sick or not), the cost of medical care is given by s. The total loss for a worker in the event of an illness is therefore two-fold. He must first seek treatment at costs s as well as forgo earnings of w while undergoing treatment. If the worker is not sick, but still undergoes treatment, he still must pay the medical cost s, but he does not need to forgo earning w.[6] Our setup allows the worker to receive compensation for his *total loss* in the event of an illness.

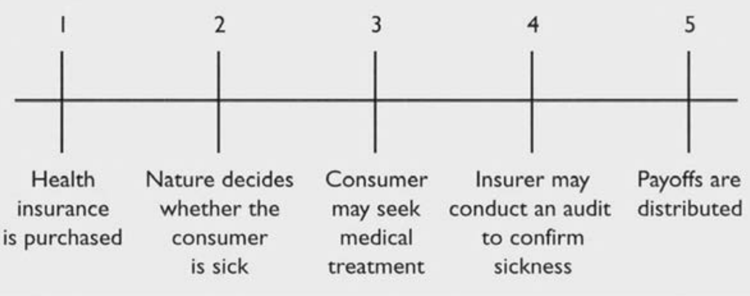
The health insurance market is perfectly competitive. That is, the premium paid by the consumer (p) is exactly equal to the expected payment in case of an illness (h) plus expenses due to fraud. In particular, the premium paid must include the expected cost of verifying whether or not the patient has sought appropriate care (i.e., auditing costs). Note that we do not limit the insurance benefit to be limited to the worker's total losses; the model permits the indemnity to exceed the loss (i.e., it could be that $h > w + s$).

After the consumer has sought treatment, the insurer chooses to audit the consumer or not in order to confirm whether the consumer needed such care. The provider's auditing costs are fixed at c. If, subsequent to an audit, it is discovered that the consumer has sought unnecessary medical treatment, the consumer suffers a utility loss of d.[7] Furthermore, the consumer is not allowed to receive compensation for his lost earnings (w), although his medical expenses are paid for (i.e., $h = s$). We chose to set the model in this manner so that auditing does not become a revenue device for the insurer. Our model reflects the case of the Canadian health care system. In this context, the public system takes care of the cost of treating the illness, whereas the private health insurer takes care of lost earnings due to the illness.[8]

The sequence of play is presented in Figure 1.

In stage 1, the health-insurance provider offers the consumer

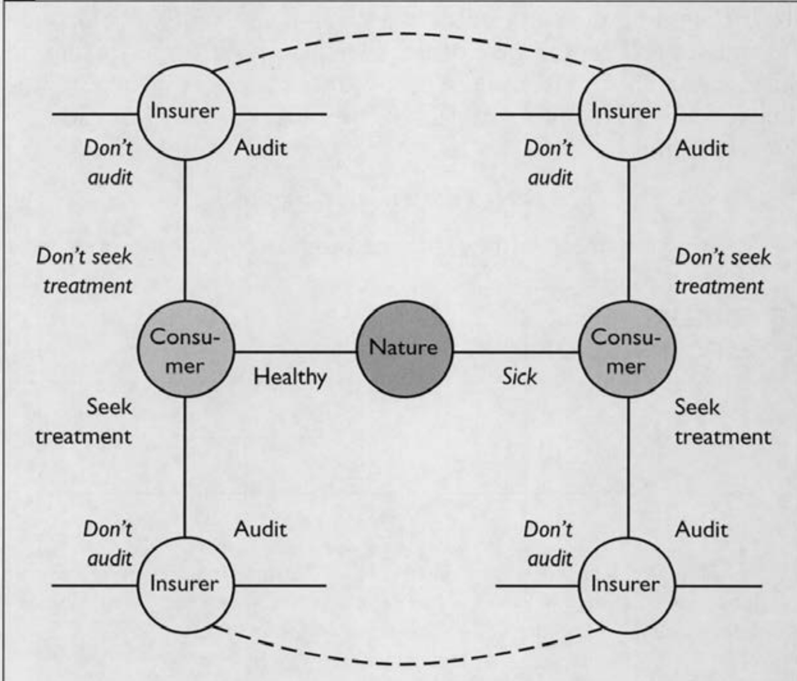
FIGURE 1
SEQUENCE OF PLAY



a contract at a premium p that specifies a coverage h in case of a loss. In stage 2, Nature decides whether the consumer is sick or not. This information is the consumer's private information. In stage 3, the consumer decides whether or not to seek medical treatment. Subsequently, the insurer decides whether to audit or not audit the consumer. Finally, the payoffs are distributed and the game ends. Stages two to five can be seen as a game of asymmetric information whose extensive form is given in Figure 2.

It is important to note in our model that a healthy consumer who seeks medical care (in order to be compensated) is assumed to be able to continue working. Although this may seem like a strong assumption, it can be interpreted in two ways. First, the health insurance contract given here has a temporary disability insurance component that compensates the worker for the time spent outside of work. In other words, the indemnity that the worker receives is similar to paid sick days. During these so-called sick days, the worker could receive compensation elsewhere (i.e., from another employer or by working for his own benefit). An alternative explanation is that the

FIGURE 2
EXTENSIVE FORM OF GAME



healthy worker who seeks unjustified medical treatments may stay home and enjoy leisure time. If the consumer chooses hours such that the marginal benefit of work is equal to the marginal cost of leisure time, an hour of paid work should be equal (in utility terms) to an hour of leisure.

Another important characteristic of our model is that it assumes that physicians are paid a fixed amount for providing care to patients (i.e. paid on a fee-for-service basis). Consequently, they have no incentive to 'turn-in' patients who lie.[9]

The consumer and the insurer play an asymmetric-information game in which the consumer knows whether or not he has suffered a loss (i.e., knows whether or not he is sick), while the insurer does not. Each player's payoffs are given in Table 2.

We derive the perfect Bayesian equilibrium by backward induction. The six elements of the Nash equilibrium are: (1) a strategy for the consumer when he is sick; (2) a strategy for the consumer when

TABLE 2 – PAYOFFS TO THE CONSUMER AND THE INSURER CONTINGENT ON THEIR ACTIONS AND THE STATE OF THE WORLD

State of the world	Action of Consumer	Action of Insurer	Payoff to Consumer	Payoff to Insurer
Healthy	*Don't Seek*	*Conduct Audit*	$U(Y-p)$	$p-c$
Healthy	Don't Seek	Don't Audit	$U(Y-p)$	p
Healthy	Seek Treatment	Conduct Audit	$U(Y-p)-d$	$p-c$
Healthy	Seek Treatment	Don't Audit	$U(Y\text{-}p\text{-}s+h)$	$p-h$
Sick	Seek Treatment	Conduct Audit	$U(Y\text{-}p\text{-}s\text{-}w+h)$	$p-h-c$
Sick	Seek Treatment	Don't Audit	$U(Y-p-s-w+h)$	$p-h$
Sick	*Don't Seek*	*Conduct Audit*	$U(Y-p-s-w)$	$p-c$
Sick	*Don't Seek*	*Don't Audit*	$U(Y-p-s-w)$	p

The contingent states in italics never occur in equilibrium. They represent actions that are off the equilibrium path.

he is healthy; (3) a strategy for the insurer when the consumer seeks treatment; (4) a strategy for the insurer when the consumer does not seek treatment; and, (5)-(6) the insurer's beliefs at each information set. The unique Nash equilibrium of this game is presented in the following lemma.

Lemma 1 For $h > \dfrac{c}{1-\pi}$, the unique Perfect Bayesian Nash Equilibrium in mixed strategies is such that:

1- The consumer always seeks treatment when sick;

2- The consumer randomizes between seeking treatments and not when he is healthy;

3- The insurer never audits a consumer that doesn't seek care;

4- The insurer randomizes between auditing and not auditing when the consumer seeks medical treatment.

Letting ϕ be the probability of seeking treatment when a consumer is healthy, and ψ be the probability of auditing given that a consumer has sought treatment, we find that

$$\phi = \left(\frac{\pi}{1-\pi}\right)\left(\frac{c}{h-c}\right) \tag{1}$$

$$\psi = \frac{U(Y-p-s+h)-U(Y-p)}{U(Y-p-s+h)-U(Y-p)+d} \tag{2}$$

The insurer's beliefs are ζ (Healthy) = 1 and ζ(Sick) = $\dfrac{h-c}{h}$, where $\zeta(.)$ refers to the belief that the signal is truthful.

Proof A sketch of the proof is provided in the appendix; see also Boyer (2000) and Léger (2000). •

The comparative statics of the Nash equilibrium are interesting. First, we note that, as the probability of being sick increases, the probability that the consumer will commit fraud increases $\left(\dfrac{\partial \phi}{\partial \pi} > 0\right)$.
This results from the fact that, as π increases, it is easier for a healthy individual to pass himself off as being sick as the pool of sick individuals is larger. It should also be noted that the probability of committing fraud increases as the cost of auditing increases $\left(\dfrac{\partial \phi}{\partial c} > 0\right)$.
This result is also intuitive. Since it is more costly for the insurer to

audit her consumer, she will be less likely to audit. Consequently, the consumer will attempt to defraud his insurer with greater probability. Surprisingly, the consumer is less likely to cheat as health benefits increase $\left(\frac{\partial \phi}{\partial h} < 0\right)$. This result is due to the fact that the insurer has greater incentive to audit as health benefits (i.e., reimbursement h) increase. Consequently, the consumer reduces his probability of committing fraud.

The model also predicts that the probability that the insurer audits decreases as the consumer's net-of-premium wealth $(Y-p)$ increases (as long as the utility function does not display increasing absolute risk aversion), if and only if the level of health benefits is greater than the cost of health care services. In other words, $\frac{\partial \psi}{\partial (Y-p)} < 0$ if and only if $h > s$.[10] That is, as the net benefit $(h - s)$ increases relative to net wealth $(Y - p)$, the incentive to commit fraud increases for the consumer. This in-turn increases the insurer's incentive to audit the consumer's health claims. Similarly, as the level of health benefit (h) increases or as the cost of medical care (s) decreases, the probability of auditing increases. This is because gains from fraud increase as h increases or s decreases, which in turn imply a greater need for audits to keep the consumer in check. Finally, the probability of auditing decreases as the penalty increases $\left(\frac{\partial \psi}{\partial d} < 0\right)$, as the consumer's incentive to commit fraud decreases.

We can now solve for the health insurance premium p that yields zero expected profits for the insurer. The equilibrium insurance premium is given by:

$$p = \pi\, h + (1 - \pi)\, h\, \phi(1 - \psi) + c\, \psi\, [\pi + (1 - \pi)\, \phi] \qquad (3)$$

where π h represents the expected treatment cost for a consumer who is truly sick. The two remaining terms in the sum represent the cost of fraud borne by society. More specifically, $(1 - \pi)\, h\, \phi\, (1 - \psi)$ represents the expected extra amount of money per policy that must be paid by the insurer to cover unnecessary treatments and $c\, \psi\, [\pi + (1 - \pi)\, \phi]$ represents the expected cost of auditing.

The health insurance contract between the consumer and the insurer must incorporate the strategic behavior of all players. That is, the insurer will anticipate rationally the strategies of all players when offering insurance policies. For example, the insurer knows that the sick consumer will always seek treatment. The insurer also knows that a healthy consumer will seek medical treatment with probability ϕ. Thus, as noted above, cheating will only occur with some positive probability when the consumer is healthy. As a result, the problem faced by the insurer becomes:

$$\max_{p,h} EU = \pi\, U(Y-p+h-s-w) + (1-\pi)\,(1-\phi)\, U(Y-p) + (1-\pi)\,\phi[(1-\psi)\, U(Y-p+h-s) + \psi\, U(Y-p) - \psi\, d] \tag{4}$$

subject to the constraints

$$p = \pi\, h + (1-\pi)\, h\, \phi\, (1-\psi) + c\, \psi\, [\pi + (1-\pi)\, \phi] \tag{5}$$

$$\phi = \left(\frac{\pi}{1-\pi}\right)\left(\frac{c}{h-c}\right) \tag{6}$$

$$\psi = \frac{U(Y-p-s+h)-U(Y-p)}{U(Y-p-s+h)-U(Y-p)+d} \tag{7}$$

and a participation constraint for the consumer. (8)

We disregard the participation constraint since it is redundant.[11] By choosing p and h, the insurer must take into account the impact of her decision on the subsequent game. By substituting (6) and (7) into (4) and (5), the above problem becomes

$$\max_{p,h} EU = \pi\, U(Y-p-s+h-w) + (1-\pi)\, U(Y-p) \tag{SP}$$

$$\text{Subject to } p = \pi\, \frac{h^2}{h-c} \tag{9}$$

The first order condition yields a health benefit (h) such that:

$$\frac{U'\left(Y-\pi\dfrac{h^2}{h-c}-s-w+h\right)}{\pi\, U'\left(Y-\pi\dfrac{h^2}{h-c}-s-w+h\right)+(1-\pi)\, U'\left(Y-\pi\dfrac{h^2}{h-c}\right)} = \frac{h(h-2c)}{(h-c)^2} \tag{10}$$

The solution to the problem does not offer much more by way of intuition,[12] except to say that the left hand side denominator represents the expected marginal utility of the consumer who purchases this contract. We note, however, that full insurance (i.e., $h = s + w$) is not a solution to this problem (unless $c = 0$, which is ruled out by assumption).

An interesting property of this optimal coverage is that the consumer's utility is maximized when he chooses a coverage greater than his possible loss ($h > s + w$). This is shown as proposition 1.

Proposition 1 The optimal indemnity is greater than the loss ($h > s + w$).

Proof All proofs are provided in the appendix. ■

The consumer's expected utility is maximized by purchasing a contract such that he is compensated for his illness by an amount greater than his actual cost. In other words, the consumer receives 'too much' insurance so that the insurer's potential benefit from auditing is greater. To see why this is the case, note that the insurer has more to lose by not auditing as the benefits increase. Therefore, as the insurance contract pays larger benefits, the insurer has a greater incentive to ensure that the consumer is indeed sick. This result is a consequence of costly auditing and of the insurer's inability to commit *ex ante* to an audit strategy.

Knowing that the insurer has more incentive to verify their health status, consumers will modify their behavior by reducing their probability of seeking unnecessary health benefits. This is made clearer by examining the probability of requesting benefits when one is healthy: As h increases, ϕ decreases $\left(\text{i.e.}: \frac{\partial \phi}{\partial h} < 0\right)$. By increasing the benefits paid to the consumer in case of illness, the probability of a false claim is reduced. A similar result is found by Picard (1996), Boyer (2004) and Schiller (2004).

The initial setup of the consumer's maximization problem allows for deductibles and co-payments, but these are not chosen in equilibrium in this framework where there are two states of the world. Boyer (2003) shows that when there are N possible states of the world, the optimal insurance contract is a combination of a deductible, a lump-sum payment and a coinsurance provision. Even with a deductible and a coinsurance provision, over-compensation is still present for larger losses, just as we have here when the higher loss, $s + w$, is over-compensated.

An interesting implication of this result is that the amount of health benefits (the reimbursement h) received by the consumer when sick is greater than the loss incurred. Boyer (2004) explains this over-compensation as representing a replacement-cost-new insurance contract. Khalil (1997) and Khalil and Parigi (1998) also obtain similar results. Using a similar framework to Baron and Myerson

(1981), Khalil finds that an agent will over-produce a given output as a means of signalling that he will not cheat. Also, Khalil and Parigi find, using Gale and Hellwig's (1987) framework, that a banker will over-lend to an entrepreneur as a signal of his willingness to verify the entrepreneur's return on his project.

Although this over-compensation result is interesting in itself, it is not new to the literature. What is innovative in this paper is its examination of what happens to over-compensation when the amount at risk varies. In other words, how does the size of lost earnings and the cost of health services affect the amount of fraud in the economy. This is the focus of the following section.

3. INFLATION

3.1 Health Care and General Inflation

The goal of this section is to evaluate the effect of an increase in potential losses associated with illness. More specifically, we evaluate the effect on the optimal insurance benefit h of 1- an increase in the costs associated with treatment s (what we call *health-care-cost inflation*), and 2- an increase in the time cost associated with lost earnings w (what we call *general inflation*). We also evaluate the effects of both health-care and general inflation on the waste associated with auditing. Note that an increase in w can be viewed as a proxy for general economic growth.

The impact of an increase in health-care costs on the optimal level of benefits is shown in the following proposition.

Proposition 2 Insurance benefits h increase as the direct cost of illness s increases, but not by the full amount; i.e., $0 < \frac{\partial h}{\partial s} < 1$.

The impact of an increase of the opportunity cost of getting sick on the optimal level of benefits is shown in the following proposition.

Proposition 3 Insurance benefits h increase as the opportunity cost of illness w increases, but not by the full amount; i.e., $0 < \frac{\partial h}{\partial w} < 1$.

Increases in both the cost of health care and in the general level of prices, as proxied by the opportunity cost of being sick, increase the amount of health insurance purchased, but by a proportion lower than the full price increase. It is logical to expect that consumers will want to purchase more insurance as it becomes more costly to get sick, whether the increased cost comes from greater higher medical expenses or from grearter lost earnings. It is not, however, obvious why this increase should be less than proportional.

In a full information economy, consumers purchase full insurance. We should therefore expect to see a one-to-one correspondence between health-benefits increases and increases in heath costs and/or lost earnings. When consumers have proprietary information regarding the state of the world, and when the insurer cannot commit to an auditing strategy *ex ante*, consumers will be over-insured (Proposition 1). What Propositions 2 and 3 tell us is that consumers are over-insured less and less as medical costs and/or lost earnings increase. This should be expected since over-insurance signals that it is too costly for the insurance company to let consumers get away with filing false claims. As the cost of illness increases, health benefits increase and the incentive for the insurer to make sure that the filed claim is truthful increases. It then becomes less important for the insurer to send the signal that it is too costly not to audit, since the rise in health care cost sends the same signal at a lower cost.

Simply put, the interpretation of the impact of a rise in the cost of illness on health benefits is driven by the fact that consumers are over-insured. In a model where the insurer is able to commit to an auditing strategy, such over-insurance should not be observed, and increases in health-care costs may or may not lead to proportional increases in the indemnity.

3.2 Impact on Waste

Although both the rise in the cost of medical care and in the cost of lost earnings have similar impacts on health benefits (both induce greater health benefits, but not proportionally so), nothing is apparent about the real cost to society of such increases. As a consequence, this section examines the effects of both general and health-care inflation on what we call the *economic and social waste (ESW)* associated with fraud.

Because consumers have an incentive to lie about their illness, insurers will wish to minimize the costs associated with unjustified claims. The simple fact that some consumers receive benefits from fraudulent claims is not, in and of itself, an ESW – it is simply a redistribution of income and has no effect on total wealth. Rather, the ESW occurs as a result of costly auditing.

More specifically, the ESW is given by:

$$ESW = [(1 - \pi)\, \phi + \pi]\, \psi\, c \tag{11}$$

The following proposition illustrates the impact of health care cost inflation (ds) and general inflation (dw) on ESW.

Proposition 4 Health-care-cost inflation and general inflation decrease ESW.

This result is interesting for several reasons. First, if the real cost of treatment increases (that is, the increase in medical-care prices is greater than the general increase in prices), than the burden imposed by health-care inflation may be over-estimated. Given that insurance providers must pay more for a given illness realization and its corresponding treatment, they will be more likely to audit patients who file such an illness-treatment claim. Given this increased incentive to audit, patients will reduce the amount of false claims they make. As a result, the probability that patients will behave fraudulently and seek unjustified medical services will decrease. Similarly, increases in the opportunity cost of time associated with illness will also decrease the amount of fraudulent claims and subsequent audits.

Although both general and health-care-cost inflation decrease the probability of fraudulent claims and, consequently, reduce the amount of ESW that is generated by audits, health-care inflation decreases ESW at a faster rate than does general inflation.

Proposition 5 Health-care-cost inflation reduces ESW more than general inflation.

This result is driven by the fact that health insurance compensates a consumer not only for costs related to medical care, but also for lost earnings associated with an inability to work when sick.[13] From an insurance payment perspective, it is irrelevant whether the cost of health services increases by a dollar or whether the opportunity cost of being sick increases by a dollar. In both cases, the consumer's monetary loss of being sick is increased by a dollar and compensation should increase accordingly. That is, in the case of illness, the impact of an increase in health-care costs on health benefits is identical to the impact of an increase in lost earnings on health benefits; i.e. $\frac{\partial h}{\partial s} = \frac{\partial h}{\partial w}$.

Given that the difference between the reduction of waste associated with health-care inflation and general inflation does not come from their respective impact on health benefits, the source of the difference must come from their impact on the two players' Nash Equilibrium Strategies.

From the consumer's probability of committing health care fraud (ϕ), it is evident that neither the health-care cost nor the opportunity cost of being unable to work has an impact on ϕ other than through health benefits. As a consequence, both types of inflation have the same impact on the consumer's probability of committing fraud, as the impact of both cost increases on health benefits is identical. We can therefore state that fraud will not be reduced following an increase in the cost of medical care or of disability benefits. The reason for this result is technical in nature and is derived from the way a mixed equilibrium is attained. In a mixed equilibrium, the only thing that matters to one player is the payoff function of the other player. In our case, the worker's probability of committing fraud depends only on the payoff to the insurer so that the insurer is indifferent between auditing and not auditing. Since $\frac{d\phi}{ds} = \frac{d\phi}{dw}$, we can say that health care cost inflation and general inflation have the same impact on a worker's probability of committing fraud.

The difference in the reduction of waste must therefore be due to a reduction in the probability of auditing (ψ) so that ψ is reduced by more following an increase in the direct health-care cost (s) than following an increase in the indirect cost of illness (w). In other words, we find that $\frac{d\psi}{ds} < \frac{d\psi}{dw}$. Note that only the cost of health care services has a direct impact on ψ (i.e., not an indirect impact on health care benefits, h). Hence, the opportunity cost of being sick (w) should not have an impact on the insurer's probability of auditing given that the opportunity cost is not incurred by consumers who commit fraud. On the other hand, healthy fraudulent consumers must seek health care services for which they have no need for if their claim is to be perceived as credible.

As the implicit cost associated with falsely signalling a 'medical need' increases (i.e., when s increases), consumers will have a reduced incentive to commit fraud; as the increase in the reimbursement they receive (in the case of a successful fraudulent claim) is less than proportional to the increase in the medical cost itself. In other words, since consumers have less to gain by committing fraud as the cost of medical services increases (as compared to an increase in the opportunity cost w), the insurance provider will find it less necessary to audit. Waste is thus reduced more by an increase in medical cost (s) than by an increase in general cost (w).

4. DISCUSSION AND CONCLUSION

The goal of this paper is two-fold. First, we examine the type of health/disability insurance contract that should be offered in an economy where the insurer is unable to commit to an auditing strategy when a consumer files a claim. Second, we examine the impact of an increase in the cost of health care services on fraud.

Assuming that consumers who are truly sick cannot work, thereby losing labor income, and that consumers who fake an illness still work (or consume an amount of leisure equivalent to the earnings he would have received if he did), we find that the optimal health insurance contract over-compensates consumers when the insurer cannot commit ex ante to an auditing strategy. This result is dependent on two important assumptions: the inability for the insurer to commit to an auditing strategy and a perfect insurance market. In our context, the perfect-health-insurance-market assumption implies that all premiums paid by the consumers are devoted to either (i) compensating the consumer, or, (ii) paying for audits.

Realistically, however, the premium paid by consumers includes not only compensation and auditing costs, but also underwriting, management, marketing and financing costs. These costs have often been modelled as a proportional loading factor on the premium paid. By adding such a proportional loading factor to the pure premium, it can easily be shown that the amount of coverage is reduced. It is perhaps this type of loading factor that prevents insurance companies from offering a contract where agents are over-compensated for their losses.

In our model, over-compensation represents a costly message sent by the insurer to the consumer. This message signals to the consumer that the insurer has more to lose by not auditing a consumer's claim, and, therefore, that the consumer should reduce accordingly his likelihood of filing a false claim. It is clear from the equilibrium condition that the consumer's probability of filing a false claim decreases as the indemnity payment increases.

Examining the impact of an increase in health care costs, the model predicts a decrease in fraudulent claims. This result is driven by the fact that as the cost of treating a patient increases so does the indemnity payment. As a result, the insurer has more to lose by not auditing, and thus, the consumer commits less fraud. The model also predicts less fraud when the opportunity cost of being sick (w) increases. As previously mentioned, it is important to note that fraud is not, in and of itself, wasteful as it is simply the redistribution of resources between agents. The real economic waste associated with fraud is the cost of auditing and the disutility of getting caught cheating. With respect to these costs, we show that an increase in the cost of health-care services reduces waste more than an increase in the opportunity cost of being sick. In other words, health-care-cost inflation reduces fraud more than general inflation.

The general conclusion we can draw from the health-care-fraud model presented here is that the real cost of health-care-cost inflation may be over-estimated in the economy since it does not incorporate the waste reduction aspect associated with less fraud. As we have shown, fraud is reduced when health-care-costs increase, provided that the cost of auditing remains unchanged. It follows that a beneficial aspect of higher medical cost may have been over-looked in the traditional health-care-cost inflation literature.

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APPENDIX
PROOFS

Proof of Lemma 1 (sketch). Let ζ(Healthy) be the the insurer's posterior belief that the agent is healthy given that he did not seek medical care (in equilibrium, is must be the case that ζ(Healthy) = 1). Now, let ϕ be the probability (in the mixed-strategy sense) that the agent seeks medical treatment when he is not ill. By Bayes' rule we can find ζ(Sick), the insurer's posterior belief that the agent suffered a real loss given that he sought medical care:

$$\zeta(Sick) = \frac{\pi}{\pi + (1-\pi)\phi}$$

Only one strategy on the part of the agent makes the insurer indifferent as to whether to audit or not. That strategy must be such that

$$\zeta(Sick) = \frac{h-c}{h}$$

Substituting for ζ(Sick) yields

$$\phi = \left(\frac{c}{h-c}\right)\left(\frac{\pi}{1-\pi}\right)$$

All that is left to calculate is the insurer's strategy when the consumer seeks medical treatment in order to make the consumer indifferent between seeking treatment and not doing when the consumer is healthy. Let ψ be the probability (in a mixed-strategy sense) of auditing an agent who seeked medical services. ψ must then be such that

$$\psi = \frac{U(Y-p-s+h) - U(Y-p)}{U(Y-p-s+h) - U(Y-p) + d}$$

Since all six elements of the PBNE have been found, the proof is done. ▪

Proof of proposition 1. All we need to show is that the first order condition is positive at $h = s + w$:

$$U'\left(Y - \pi\frac{h^2}{h-c} - s + h\right)\left[1 - \pi\frac{h(h-2c)}{(h-c)^2}\right] - (1-\pi)\,U'\left(Y - \pi\frac{h^2}{h-c} + w\right)\pi\frac{h(h-2c)}{(h-c)^2} \geq 0 \tag{12}$$

Letting $h = s + w$ and simplifying, we find that (12) holds if and only if

$$1 - \frac{h(h-2c)}{(h-c)^2} \geq 0 \tag{13}$$

This clearly holds if $c > 0$. Therefore $h > s + w$. ▪

APPENDIX
PROOFS (CONTINUED)

Proof of proposition 2

a) We first want to show that $\frac{dh}{ds}$ > 0. Let Ω represent the first order condition rewritten as

$$\Omega = U'\left(Y - \pi\frac{h^2}{h-c} - s + h\right)\left[(h-c)^2 - \pi h(h-2c)\right]$$
$$-(1-\pi)\,U'\left(Y - \pi\frac{h^2}{h-c} + w\right)h(h-2c) = 0 \qquad (14)$$

Using total derivatives, we know that $\frac{\partial\Omega}{\partial h}dh + \frac{\partial\Omega}{\partial s}ds = 0$, where

$$\frac{d\Omega}{ds} = -\left[(h-c)^2 - \pi h(h-2c)\right]U''\left(Y - \pi\frac{h^2}{h-c} - s + h\right) \qquad (15)$$

$$\frac{\partial\Omega}{\partial h} = 2(1-\pi)(h-c)\left[U'\left(Y - \pi\frac{h^2}{h-c} - s + h\right) - U'\left(Y - \pi\frac{h^2}{h-c} + w\right)\right]$$
$$+(1-\pi)\,h(h-2c)\,\pi\frac{h(h-2c)}{(h-c)^2}\left[U''\left(Y - \pi\frac{h^2}{h-c} + w\right) - U''\left(Y - \pi\frac{h^2}{h-c} - s + h\right)\right]$$
$$+(1-\pi)\,h(h-2c)\,U''\left(Y - \pi\frac{h^2}{h-c} - s + h\right) \qquad (16)$$
$$+c^2\left[1 - \pi\frac{h(h-2c)}{(h-c)^2}\right]U''\left(Y - \pi\frac{h^2}{h-c} - s + h\right)$$

Since $\frac{d\Omega}{ds} > 0$ and $\frac{\partial\Omega}{\partial h} < 0$,[14] it follows that $\frac{dh}{ds}$ > 0, as we wanted to show.

b) We now want to show that this increase in health benefits is smaller than the increase in health care cost; i.e., $\frac{dh}{ds}$ < 1. This occurs when

APPENDIX
PROOFS (CONTINUED)

$$\frac{dh}{ds}=-\frac{\frac{\partial\Omega}{\partial s}}{\frac{\partial\Omega}{\partial h}}=-\frac{-[(h-c)^2-\pi h(h-2c)]\,U''\left(Y-\pi\frac{h^2}{h-c}-s+h\right)}{\left[\begin{array}{l}2(1-\pi)(h-c)\left[U'\left(Y-\pi\frac{h^2}{h-c}-s+h\right)-U'\left(Y-\pi\frac{h^2}{h-c}+w\right)\right]\\+(1-\pi)\,h(h-2c)\,\pi\frac{h(h-2c)}{(h-c)^2}\left[U''\left(Y-\pi\frac{h^2}{h-c}+w\right)-U''\left(Y-\pi\frac{h^2}{h-c}-s+h\right)\right]\\+(1-\pi)\,h(h-2c)\,U''\left(Y-\pi\frac{h^2}{h-c}-s+h\right)\\+c^2\left[1-\pi\frac{h(h-2c)}{(h-c)^2}\right]U''\left(Y-\pi\frac{h^2}{h-c}-s+h\right)\end{array}\right]}<1 \qquad (17)$$

We know that $\frac{\partial\Omega}{\partial h}<0$. Combining terms we find that $\frac{dh}{ds}<1$ if and only if

$$\left[\begin{array}{l}2(1-\pi)(h-c)\left[U'\left(Y-\pi\frac{h^2}{h-c}-s+h\right)-U'\left(Y-\pi\frac{h^2}{h-c}+w\right)\right]\\+(1-\pi)\,h(h-2c)\,\pi\frac{h(h-2c)}{(h-c)^2}\left[U''\left(Y-\pi\frac{h^2}{h-c}+w\right)-U''\left(Y-\pi\frac{h^2}{h-c}-s+h\right)\right]\\+\pi hc\frac{h^2-3hc+3c^2}{(h-c)^2}\,U''\left(Y-\pi\frac{h^2}{h-c}-s+h\right)\end{array}\right]<0 \qquad (18)$$

A sufficient condition for (18) to hold is that

$$\pi hc\frac{h^2-3hc+3c^2}{(h-c)^2}>0 \qquad (19)$$

The reason is that the first two lines of (18) are negative since $h>s$, and that $U''(.)<0$. The zeros of (19) are $h=0$, $h=\frac{3}{2}c+\frac{1}{2}ic\sqrt{3}$, and $h=\frac{3}{2}c-\frac{1}{2}ic\sqrt{3}$. It is therefore clear that (19) holds for any real h. Hence, $\frac{dh}{ds}<1$. •

Proof of proposition 3

a) We first want to show that $\frac{dh}{dw}>0$. We already have $\frac{\partial\Omega}{\partial h}$ from (16). We must now find $\frac{\partial\Omega}{\partial w}$ as

$$\frac{d\Omega}{dw}=-(1-\pi)\,U''\left(Y-\pi\frac{h^2}{h-c}+w\right)h(h-2c) \qquad (20)$$

APPENDIX
PROOFS (CONTINUED)

Clearly $\frac{d\Omega}{dw} > 0$. Given that $\frac{\partial\Omega}{\partial h} < 0$, it follows that $\frac{dh}{dw} > 0$, as we wanted to show.

b) Similarly to proposition 2's part b) proof, we want to show that $\frac{dh}{dw} < 1$. Given that $\frac{\partial\Omega}{\partial h} < 0, \frac{dh}{dw} < 1$ occurs if and only if $\frac{\partial\Omega}{\partial w} - \frac{\partial\Omega}{\partial h} < 0$. Combining terms we find that $\frac{dh}{dw} < 1$ holds if and only if

$$\left[\begin{array}{l} 2(1-\pi)(h-c)\left[U'\left(Y-\pi\frac{h^2}{h-c}-s+h\right)-U'\left(Y-\pi\frac{h^2}{h-c}+w\right)\right] \\ +(1-\pi)\,h(h-2c)\,\pi\frac{h(h-2c)}{(h-c)^2}\left[U''\left(Y-\pi\frac{h^2}{h-c}+w\right)-U''\left(Y-\pi\frac{h^2}{h-c}-s+h\right)\right] \\ +\left(1-\pi\frac{h(h-2c)}{(h-c)^2}\right)c^2U''\left(Y-\pi\frac{h^2}{h-c}-s+h\right) \end{array}\right]<0 \tag{21}$$

A sufficient condition for (21) to hold is that $1 - \pi\ \frac{h(h-2c)}{(h-c)^2} > 0$, which clearly holds for c > 0. Hence, $\frac{dh}{dw} < 1$. ▪

Proof of proposition 4

From (11), we find

$$\frac{dESW}{ds}=(1-\pi)\frac{d\phi}{ds}\psi c+\left[(1-\pi)\,\phi+\pi\right]\frac{d\psi}{ds}<0 \tag{22}$$

and

$$\frac{dESW}{dw}=(1-\pi)\frac{d\phi}{dw}\psi c+\left[(1-\pi)\,\phi+\pi\right]\frac{d\psi}{dw}<0 \tag{23}$$

because $\frac{d\phi}{ds}<0$, $\frac{d\psi}{ds}<0$, $\frac{d\phi}{dw}<0$ and $\frac{d\psi}{dw}<0$. ▪

Proof of proposition 5

Using (22) and (23), we want to show that $\frac{dESW}{ds}<\frac{dESW}{dw}$. This occurs if and only if

$$(1-\pi)\left(\frac{d\phi}{ds}-\frac{d\phi}{dw}\right)\psi c+\left[(1-\pi)\,\phi+\pi\right]\left(\frac{d\psi}{ds}-\frac{d\psi}{dw}\right)c<0 \tag{24}$$

APPENDIX
PROOFS (CONTINUED)

Since $\frac{d\phi}{ds}-\frac{d\phi}{dw}=\frac{\partial\phi}{\partial h}\frac{\partial h}{\partial s}-\frac{\partial\phi}{\partial h}\frac{\partial h}{\partial w}=\frac{\partial\phi}{\partial h}\left(\frac{\partial h}{\partial s}-\frac{\partial h}{\partial w}\right)$ and since $\frac{\partial h}{\partial s}-\frac{\partial h}{\partial w}$ $= 0$, it follows that $\frac{d\phi}{ds}-\frac{d\phi}{dw}$ $= 0$. To see why, note that

$$\frac{dh}{ds}=-\frac{-\left[(h-c)^2-\pi h(h-c)\right]U''\left(Y-\pi\frac{h^2}{h-c}-s-w+h\right)}{\frac{\partial\Omega}{\partial h}}=\frac{dh}{dw} \tag{25}$$

What remains is that $\frac{dZ}{ds}<\frac{dZ}{dw}$ if and only if $\frac{d\psi}{ds}-\frac{d\psi}{dw}<0$

Rewriting $\frac{d\psi}{ds}$ and $\frac{d\psi}{dw}$ as

$$\frac{d\psi}{ds}=\frac{\partial\psi}{\partial s}+\frac{\partial\psi}{\partial h}\frac{\partial h}{\partial s} \text{ and } \frac{d\psi}{dw}=\frac{\partial\psi}{\partial h}\frac{\partial h}{\partial w} \tag{26}$$

we thus have

$$\frac{d\psi}{ds}<\frac{d\psi}{dw} \text{ if } \frac{\partial\psi}{\partial s}+\frac{\partial\psi}{\partial h}\frac{\partial h}{\partial s}-\frac{\partial\psi}{\partial h}\frac{\partial h}{\partial w}<0 \tag{27}$$

Given that $\frac{\partial h}{\partial s}=\frac{\partial h}{\partial b}$ (see equation 25), all that is left to show is that

$$\frac{\partial\psi}{\partial s}=-\frac{U'(Y-p-s+h)d}{\left[U(Y-p-s+h)-U(Y-p)+d\right]^2}<0 \tag{28}$$

which is obvious. Hence $\frac{dESW}{ds}<\frac{dESW}{dw}$ < 0. ▪

Notes

1. For example, physicians who are paid by fee-for-service may wish to encourage their patients to consume care beyond efficient levels (i.e., supplier-induced-demand) (Arrow (1963), Evans (1974), Stano (1987) and Dranove (1988)).

2. For example, Newhouse (1992) and Blomqvist (1997) attempt to measure the welfare loss of health-care insurance.

3. Throughout the paper, we use the term "health care inflation" for any increase in health care costs, whether it is due to a per unit increase in the price of treatment, or technology or treatment norms.

4. Throughout the paper, the masculine identifies the agent, while the feminine identifies the principal.

5. This assumption is a technical condition of the model that guarantees mixed strategy equilibria (it its absence pure strategy equilibria would occur where consumers would always cheat and insurers would never audit).

6. This aspect of the game is peculiar: Why would a healthy worker seek unnecessary treatments? Why does he not need to sacrifice his earning? To answer the first question, note that the contract includes a short-term disability benefit that any healthy worker would like to receive. To answer the second question, think of a manual labourer who claims back spasms to receive pain medication, but who still does manual labour in his yard or in his brother-in-law's. We discuss further this aspect of the model later in the paper.

7. We can view this as a loss of reputation, a fine or even prison time. The important part of the penalty is that it is exogenous to the model. Indeed, Becker (1968) showed that if fines were part of the insurance contract (where fines are paid to the insurer), the insurance provider would set fines te be very large essentially reducing the probability of consumer cheating and provider auditing to zero. In our model, the disutility of being caught may also be viewed as the forgone utility of being shunned from the health insurance market after getting caught.

8. Our paper examines the case where services are over-demanded, as opposed to over-supplied as in many other health insurance frameworks.

9. This absence of incentive to turn in patients who commit fraud comes directly from the assumption that the medical providers are paid the same amount no matter whether the patients is truly sick or not.

10. As is shown further on, the level of health benefits is in fact greater than the cost of health care services.

11. The participation constraint states that the agent must be at least as well off with the contract then in autarchy. It is easy to show that autarchy is similar to choosing $h = 0$. Therefore the participation constraint binds only if $h < 0$, which does not occur.

12. Because the left hand side of (10) is positive, h must be greater than 2c for the right hand side to be positive. This is to be expected as the premium is a convex function of coverage that reaches a minimum at $h = 2c$. For all $c < h < 2c$ the premium decreases with coverage, while for $h > 2c$, price increases with coverage. Since the consumer prefers more coverage to less, the tangency between the utility function and the convex zero-profit constraint must lie on the upward sloping portion of the price function, which occurs when $h \geq 2c$. As a result, the optimal level of coverage is necessarily more than twice as large as the cost of auditing. It also implies that $\pi < \frac{1}{2}$ is a sufficient condition to yield an equilibrium in mixed strategies for the game, as stated in the assumptions.

13. Another component of the cost of fraud is the disutility of getting caught. This waste is given by $ESW' = (1 - \pi)\,\phi\,\psi\,k$. It is also clear that an increase in s reduces waste more than an increase in w. In other words, $\frac{dESW'}{ds} < \frac{dESW'}{dw}$. To see why, note that we have $\frac{dESW'}{ds} < \frac{dESW}{dw}$ if and only if

$$(1-\pi)\left(\frac{d\phi}{ds}-\frac{d\phi}{dw}\right)\psi k+(1-\pi)\left(\frac{d\psi}{ds}-\frac{d\psi}{dw}\right)\phi k<0$$

Given that $\frac{d\phi}{ds}-\frac{d\phi}{dw}=0$ and that $\frac{d\psi}{ds}-\frac{d\psi}{dw}$ (see the proof of proposition 5), it follows that an increase in health care inflation reduces waste associated with getting caught more than an increase in general inflation as measured by the opportunity cost of being sick.

14. $\frac{\partial\Omega}{\partial h}$ is negative since each line is negative:

$$\left[U'\left(A-\pi\frac{h^2}{h-c}-s+h\right)-U'\left(A-\pi\frac{h^2}{h-c}\right)\right]$$

negative since $h > s$, as shown in proposition 1,

$$(1-\pi)\,h(h-2c)\,\pi\frac{h(h-2c)}{(h-c)^2}\left[U''\left(A-\pi\frac{h^2}{h-c}\right)-U''\left(A-\pi\frac{h^2}{h-c}-s+h\right)\right]$$

for the same reason, and

$$(1-\pi)\,h(h-2c)\,U''\left(A-\pi\frac{h^2}{h-c}-s+h\right)+c^2\left[1-\pi\frac{h(h-2c)}{(h-c)^2}\right]U''\left(A-\pi\frac{h^2}{h-c}-s+h\right)$$

is clearly negative since $U''(.)$ is negative.