

Welfare-Improving Health Expenditure Subsidies

By WILLIAM JACK AND LOUISE SHEINER*

The tax treatment of employer-paid health insurance is widely believed to encourage the overconsumption of health care in the United States. Under current U.S. law, employer-paid health insurance premiums are deductible as a business expense of the employer, but are not included in the employee's taxable income. This tax treatment effectively subsidizes employer-paid health insurance at a rate equal to the employee's marginal tax rate.

Martin S. Feldstein (1973) and Feldstein and Bernard Friedman (1977) were among the first to analyze the impact of this favorable tax treatment on the consumption of health care services. They calculated the impact of the tax subsidy on the choice of insurance and on welfare, using a range of estimates for the degree of risk aversion and the elasticity of demand for health. They found that in the absence of the tax subsidy, coinsurance rates would be significantly higher and health spending significantly reduced, compared with the status quo. Following this work, and using more detailed empirical evidence on demand elasticities, a number of studies examined the quantitative significance of expanded levels of insurance, typically by estimating reductions in health spending from moving to greater cost-sharing rules on the demand side.¹

* Jack: Centre for Economic Policy Research, Australian National University, Canberra, ACT 0200, Australia (e-mail: billy.jack@anu.edu.au); Sheiner: Federal Reserve Board of Governors, Stop 83, Washington, DC 20551 (e-mail: lsheiner@frb.gov). The views expressed in this paper represent those of the authors and should not be attributed to the Federal Reserve. We are grateful to Tom Bowne, Darrel Cohen, Greg Duffee, Meg Meyer, Alan Viard, and three anonymous referees for helpful comments, while retaining responsibility for any errors.

¹ Supply-side cost sharing, in terms of prospective payments to providers, has been discussed by Randall P. Ellis and Thomas G. McGuire (1993), but is not addressed in this paper.

Willard G. Manning et al. (1987) used data from the RAND experiment to estimate the effects of moving to higher coinsurance rates, using simple Harberger triangles to measure the welfare impact. Roger Feldman and Bryan E. Dowd (1991) incorporated a measure of risk aversion into their analysis, and compared the welfare levels of high and low cost-sharing arrangements (25% and 95% coinsurance rates). Howard A. Chernick et al. (1987) examined the empirical link between the tax subsidy and the choice of insurance and found that earlier estimates by Feldstein and Friedman (1977) of the quantitative effect on health spending of removing the subsidy may have been overstated.

While economists generally agree that the subsidy to employer-provided health insurance reduces welfare, it seems unlikely that the favorable tax treatment will be repealed in the near future. In this paper, we develop a model to examine the effects of a wider variety of tax subsidies. In particular, we examine the effects of providing subsidies to out-of-pocket expenditures, under the assumption that political constraints preclude the repeal of the existing subsidy. Allowing the use of pretax income to make out-of-pocket payments for health services has been advocated as a way of giving individuals more discretion over consumption patterns, and encouraging more efficient choice of insurance (Gail A. Jensen and Robert J. Morlock, 1994). This general approach has been manifest, for example, in proposals to create so-called "medical savings accounts" (MSAs), tax-favored savings accounts from which medical expenses can be paid, and for the extension of cafeteria plans and flexible spending arrangements (FSAs) (U.S. Congress, 1993 pp. 1043–47). Economists have tended to argue, however, that adding a further subsidy to the existing tax system will only lead to higher health expenditures and lower welfare (Dowd and Feldman, 1987; U.S. Department of Health and Human Services, 1985).

We develop a model to assess these conflicting views about the effects of subsidizing out-of-pocket health expenses. While our model does not address the specific provisions of medical savings accounts or flexible spending arrangements, our results can shed light on the likely effects of these policies.² We find that, in the presence of an existing subsidy to premium payments, subsidies to out-of-pocket expenditures can in fact reduce total health expenditures toward the subsidy-free level. Under the assumption that the existing subsidy reduces welfare, the introduction of the additional subsidy is welfare improving.³

In our model, insurance is purchased because health status is uncertain. However, health status is not directly observable by the insurance provider, and insurance payouts are based on health expenditures. *Ex post* overconsumption or moral hazard thus makes complete insurance undesirable.⁴ Individuals are *ex ante* identical, so adverse selection problems associated with market segmentation do not arise. In particular, the possibility that insurance companies try to attract good

risks is not modeled here. Premium subsidies lead individuals to buy overly generous insurance policies. Given such behavior, it would appear that introducing a subsidy to coinsurance would increase health spending and reduce welfare further. However, this intuition assumes that the form of the health insurance contract is fixed. In fact, we show that the likely effect of providing a subsidy to coinsurance will be to alter the insurance contract in such a way that the effective coinsurance rate faced by the individual is higher than that without the subsidy, and that welfare will be increased toward the subsidy-free level.

This can be seen by conducting the following thought experiment. Assume that insurance contracts consist of a premium P and coinsurance rate κ . When there are no subsidies, the individual chooses κ such that the loss in welfare from the increase in risk from a marginal increase in the coinsurance rate is just offset by the increase in welfare associated with the resulting reduction in premium and reduced utilization. Now suppose a coinsurance subsidy is introduced, so that the government shares some of the out-of-pocket costs of medical care. The individual could undo the price effect of the subsidy by choosing a higher contractual coinsurance rate, leaving the subsidy-inclusive, or effective, coinsurance rate unchanged from before. However, the premium, which covers the expected value of expenditures not paid by the individual or the government, would fall, and the consumer would face the same effective price of health services with higher income. At that point, would the consumer choose to increase or reduce the effective rate of coinsurance? There are two effects. First, because the government now pays a greater fraction of health care costs, the private cost of moral hazard is lower, inducing the consumer to lower the effective rate of coinsurance and to purchase more health. However, holding utilization of health services constant, the coinsurance subsidy makes increasing the rate of coinsurance cheaper than before. This effect encourages the consumer to choose a higher rate of coinsurance. As we show formally in Section III, if the elasticity of demand for health services

² Both FSAs and MSAs allow employees to pay for noninsured medical expenses with pretax dollars. FSAs, however, have a "use-it-or-lose-it" provision, whereby money must be allocated to the FSA at the beginning of the year, and any balance not spent by the end of the year is forfeited. Under most MSA proposals, unused contributions are kept for future years, earnings on the account are tax free, and any balance remaining at retirement can be withdrawn without tax. Thus, MSAs essentially provide an unlimited subsidy to out-of-pocket expenditures. However, most proposals would restrict the availability of MSAs to those who purchase catastrophic health insurance.

³ Clearly in this case the first-best policy is removal of the existing subsidy, but we assume that political constraints preclude such a response. If market failures such as externalities and adverse selection mean that some form of subsidization is optimal, the welfare implications of our analysis are less clear. However, it remains true that the additional subsidy reduces health care spending.

⁴ Overconsumption of health results from the inability of insurers to observe and write contracts based on an individual's health status (or type), rather than any problem observing the actions of the individual. This type of incentive problem has been labeled "hidden information moral hazard" (for example, see Oliver Hart and Bengt Holmström, 1987).

is less than one, the second effect will dominate, and subsidizing coinsurance payments will induce the consumer to choose a higher effective rate of coinsurance. Under this condition, we also show that there exists a coinsurance subsidy rate which leads the individual to choose an effective coinsurance rate equal to the subsidy-free rate. That is, the negative effects of the current subsidy to health insurance can be offset exactly with a further subsidy to coinsurance. Furthermore, we show that under general conditions, the optimal subsidy to coinsurance is greater than the existing subsidy to premiums.

Section I of the paper presents a model of the choice of insurance contract with no subsidies. The analysis is extended in Section II to the situation in which premium and coinsurance payments are subsidized at different rates, and the optimal contract is described. Section III addresses the impact of each of the subsidies separately on the form of the insurance contract and health expenditures, as well as the optimal coinsurance subsidy, given the premium subsidy. Numerical simulations are performed in Section IV, where account also is taken of the possible deadweight loss associated with financing the subsidies. We show that if health subsidies are financed with distortionary taxes, the optimal subsidy to coinsurance and the welfare gains from optimally subsidizing coinsurance are reduced substantially. However, for most reasonable parameters, coinsurance subsidies can still improve welfare. Conclusions and policy implications are discussed in Section V.

I. Optimal Insurance: The Subsidy-Free Case

We consider a simple situation in which a consumer chooses a health insurance contract consisting of a fixed coinsurance rate κ for incurred medical expenditures, and an up-front premium payment P . Consumers are *ex ante* identical, but after paying the premium can suffer *ex post* health problems. The representative consumer's utility is given by $U(C, H)$, where H is health, and C is consumption of a composite good. Income is exogenous and fixed at W , and the consumer's health status is modeled by θ ; θ is the effective price of health

without insurance, and is higher for individuals with more health problems. Note that H is *not* a measure of health services, such as doctor visits. The high price of health for an unhealthy individual (high θ) can be thought of as a high required number of doctor visits to attain a given level of health.⁵

For a given insurance contract, the effective price of health in a particular state of the world is $\kappa\theta$, and net income is $W - P$. After the insurance contract is chosen and the individual observes the state of the world, the consumer chooses health and other consumption to solve the following problem:

$$(1) \quad \max_{C, H} U(C, H)$$

$$s.t. \quad W - P = C + \kappa\theta H,$$

yielding demands $C(\kappa\theta, W - P)$ and $H(\kappa\theta, W - P)$, and indirect utility

$$(2) \quad V(\kappa\theta, W - P)$$

$$\equiv U(C(\kappa\theta, W - P), H(\kappa\theta, W - P)).$$

Consumers buy insurance because θ is uncertain. Assuming the conditions of the expected utility theorem hold, the optimal insurance contract solves

$$(3) \quad \max_{\kappa, P} \Psi = \int V(\kappa\theta, W - P) dF(\theta),$$

⁵ An alternative formulation of the problem is to write utility as a direct function of medical services consumed. By assuming here that there is a single good called "health," and that it has an uncertain scalar price, we are implicitly assuming that either: (i) there is only one kind of sickness, which requires the same mix of medical services, just at different levels, or (ii) insurance contracts cannot be written to differentiate between expenditures on different medical services. For illustration, assume there are two health services, X and Y , which can be combined to produce H . Then in (i) we are assuming that isoquants in (X, Y) -space are fixed, and an increase in θ shifts the isoquants out. In particular, a change in health status does not affect the slope of the isoquants (which would otherwise induce a shift between medical services consumed). These assumptions constrain the capacity of the model to deal with differential insurance rates for physician, hospital, prescription drug, and mental health services, for example. See Timothy J. Besley (1988) for a relevant model.

where $F(\cdot)$ is the distribution function of θ . The consumer's choice in equation (3) is constrained by the fact that the insurance company must make nonnegative expected profits.⁶ We assume that the insurance industry is competitive, so that, in equilibrium, profits are zero. This requires that

$$\begin{aligned}
 (4) \quad P &= (1 - \kappa) \int \theta H dF(\theta) \\
 &= (1 - \kappa) \int q(\theta) dF(\theta) \\
 &= (1 - \kappa)\bar{q},
 \end{aligned}$$

where $q(\theta) \equiv \theta H(\kappa\theta, W - P)$ is defined as total expenditures on health in state of the world θ , of which the consumer pays only a fraction κ directly out of pocket, and mean values are denoted by a bar.⁷ Note that in each state of the world the insurance company pays $(1 - \kappa)q(\theta)$, but cannot base its payment on θ (or H) directly. Thus, we assume that total expenditures (i.e., doctors' bills, etc.) are contractible, but that health status (θ) is not directly observable by the insurer.⁸ The consumer performs the maximization in equation (3) subject to equation (4).⁹ Since equation (4) implicitly defines the

⁶ Without loss of generality, we assume there are no administrative costs associated with providing insurance.

⁷ For notational convenience we suppress the dependence of q on κ and $W - P$.

⁸ This is surely a simplifying assumption, since utilization review, etc., are possible. However, it captures the essential feature of fee-for-service insurance.

⁹ This optimization problem is similar to the optimal linear income tax problem (for example, see Nicholas H. Stern, 1976; Anthony B. Atkinson and Joseph E. Stiglitz, 1980), with the price of health, θ , corresponding to the wage rate. Only expenditures are observable, and hence contractible, by the insurance company; however, separately θ and H are not observable, just as only income, and not labor supply, is observable and hence taxable by the government in the income tax problem. A further similarity between this model and the optimal tax literature is that the maximization problem is not guaranteed to be well behaved. However, we assume that the first-order approach is satisfactory here. K. Cotter (1994) applies the nonlinear optimal income tax model in the health insurance context.

premium as a function of κ , we can differentiate Ψ with respect to κ to yield the condition

$$\begin{aligned}
 (5) \quad &\int \theta V_1(\kappa\theta, W - P) dF(\theta) - P'(\kappa) \\
 &\times \int V_2(\kappa\theta, W - P) dF(\theta) = 0,
 \end{aligned}$$

where the subscripts on V denote partial differentiation with respect to the first and second arguments. Using Roy's identity, $V_1 = -HV_2$, and relabeling the marginal utility of income as α , this first-order condition can be rewritten as

$$(6) \quad \int \alpha q dF = -\bar{\alpha} P'(\kappa).$$

Note from equation (4) that the derivative of the premium with respect to the coinsurance rate is just

$$(7) \quad P'(\kappa) = -\bar{q} + (1 - \kappa) \frac{d\bar{q}}{d\kappa},$$

where $d\bar{q}/d\kappa$ is the net derivative of \bar{q} with respect to κ , including the effect on \bar{q} of any change in P induced by the change in κ .¹⁰ Equation (6) can then be rearranged to yield

$$\begin{aligned}
 (8) \quad &\int \alpha q dF - \bar{\alpha} \bar{q} \equiv \text{cov}(q, \alpha) \\
 &= -\bar{\alpha} (1 - \kappa) \frac{d\bar{q}}{d\kappa}.
 \end{aligned}$$

The left-hand side of equation (8) measures the direct cost of increasing κ . Holding q

¹⁰ This net-of-premium-adjustments demand derivative, and the associated elasticity, will be important parameters in the analysis to follow. It is straightforward to show that $d\bar{q}/d\kappa$ can be expressed as $d\bar{q}/d\kappa = (\bar{q}_\kappa + \bar{q} \bar{q}_m) / (1 + (1 - \kappa)\bar{q}_m)$, where m refers to the argument $W - P$, and subscripts here denote normal demand derivatives (i.e., \bar{q}_κ and \bar{q}_m are the derivatives, holding the premium constant, of \bar{q} with respect to κ and m , respectively). Properties of the net demand function in terms of the normal demand functions are established in Appendix Proposition A2 and its corollaries. In general, $d\bar{q}/d\kappa$ will be close to \bar{q}_κ when \bar{q}_m is small.

constant in each state of the world, a small increase $d\kappa$ increases out-of-pocket expenditures by $qd\kappa$, but reduces the premium by $\bar{q}d\kappa$. The net effect, measured in expected utility terms, is $\int \alpha(qd\kappa) dF - \bar{\alpha}\bar{q}d\kappa$, which is just the covariance between α and q . Holding q constant in each state of the world, increasing the coinsurance rate leaves the total expected costs of health expenditures unchanged, but increases the consumer's exposure to uncertain health expenses. The net value of this increase in risk is measured by the covariance between α and q .¹¹

The covariance is positive as long as the marginal utility of income generally is higher the higher are medical expenditures. We assume throughout that for any given coinsurance rate, sicker people consume more medical services (i.e., that q covaries positively with θ), so that a sufficient condition for the covariance to be positive is that the marginal utility of income is increasing in θ .¹² This assumption seems reasonable since it is necessary to yield the kinds of insurance contracts typically observed, namely those with coinsurance rates less than one. As we prove formally in Appendix Proposition A1, this will be true only if people are risk averse "enough." Health insurance does not equalize prices in all states of the world, but rather transfers income to states of the world in which health expenditures are high. If individuals are only slightly risk averse, the gain from reducing the variance of consumption may not be high enough to offset the cost of transferring income to states of the world in which the purchasing power of that income is low because prices are high.

The right-hand side of equation (8) measures the effect on welfare of the changes in

utilization of health services induced by a change in the coinsurance rate, $d\bar{q}/d\kappa$, which we assume is negative.¹³ This change in utilization has three effects on welfare. First, the reduction in health expenditures $dq(\theta)$ in each state of the world decreases welfare by $\kappa dq(\theta)$. Because the consumer optimizes over C and H given κ , this decrease in welfare is exactly offset by a second effect, the reduction of $\kappa dq(\theta)$ out-of-pocket coinsurance payments. Finally, lower health expenditures induce a change in the premium of $(1 - \kappa)d\bar{q}$. The net effect on welfare of the change in utilization derives only from the effect on the premium, the value of which is just the right-hand side of equation (8). This can be viewed as a measure of the moral hazard associated with health insurance. When the coinsurance rate κ is less than one, the consumer faces a price for health in each state of the world, $\kappa\theta$, which is less than the shadow cost, θ , leading to an overconsumption of health. The first-order condition (8) then balances the additional benefits of reduced moral hazard against the costs of greater risk exposure associated with a marginal increase in κ .

Assuming the covariance between q and α is positive, then as long as $d\bar{q}/d\kappa$ is negative, equation (8) indicates that the optimal coinsurance rate is less than one: consumers do choose to purchase some insurance. Full insurance, characterized by a coinsurance rate of zero, is not optimal as long as the demand for health is sensitive to the *ex post* price. If there is no such price sensitivity, then the moral hazard costs of low out-of-pocket payment obligations are zero, and the optimal contract reduces risk exposure fully to zero. Of course, in this case, subsidizing health would have no efficiency consequences.

¹¹ The endogeneity of α and q makes interpretation of the covariance term somewhat problematic, as is the case in any asset-pricing model.

¹² Note that this assumption rules out Cobb-Douglas preferences, under which expenditures on health are equal to a constant share of income and are invariant to price, so that the covariance between q and α is zero. Given that reducing κ creates moral hazard but does not affect risk, consumers with Cobb-Douglas preferences will choose a coinsurance rate of one; i.e., they will not purchase any insurance.

¹³ It does not seem unreasonable to assume that, even accounting for the fact that increasing κ lowers the premium [from equation (6), it is clear that at the optimum $P'(\kappa)$ is less than zero] and thus increases income, aggregate health expenditures decrease with the coinsurance rate. As we show formally in Appendix Corollary A1, when there are no subsidies to out-of-pocket payments, all that is required for this to be true is that the standard price elasticity of demand for health be less than one, and that sicker people spend more of any additional income on health.

II. Subsidies to Health Expenditures

We now consider the problem of insurance choice when health insurance premiums and coinsurance payments are subsidized. For generality, we assume that these two different components of health expenditure possibly are subsidized at different rates. The subsidy rate for premiums is s , that for coinsurance is σ , and these subsidies are financed by a lump-sum tax T . We only consider values of s and σ less than one. Under a given insurance contract (κ, P) , the consumer's budget constraint in state of the world θ is then

$$(9) \quad C + \kappa(1 - \sigma)\theta H = W - P(1 - s) - T.$$

Define the effective after-tax coinsurance rate $\hat{\kappa}$, the after-tax premium \hat{P} , and after-tax exogenous income \hat{W} by $\hat{\kappa} = \kappa(1 - \sigma)$, $\hat{P} = P(1 - s)$, and $\hat{W} = W - T$, respectively. The consumer's budget constraint in state of the world θ can then be written as

$$(10) \quad C + \hat{\kappa}\theta H = \hat{W} - \hat{P},$$

and the insurance company's zero-profit constraint is

$$(11) \quad P - (1 - \kappa)\bar{q} = \frac{\hat{P}}{1 - s} - \left(1 - \frac{\hat{\kappa}}{1 - \sigma}\right)\bar{q} = 0.$$

Finally, the government's budget is balanced, so T satisfies

$$(12) \quad T = sP + \sigma\kappa\bar{q} = \frac{s}{1 - s}\hat{P} + \frac{\sigma}{1 - \sigma}\hat{\kappa}\bar{q}.$$

We write the consumer's optimization problem in terms of the effective after-tax variables $\hat{\kappa}$ and \hat{P} . Written this way, the subsidies only affect the consumer through the constraint equation (11). Specifically, $\hat{\kappa}$ and \hat{P} are chosen to maximize expected utility

$$(13) \quad \max_{\hat{\kappa}, \hat{P}} \Psi = \int V(\hat{\kappa}\theta, \hat{W} - \hat{P}(\hat{\kappa})) dF(\theta)$$

subject to equation (11). While changes in $\hat{\kappa}$ clearly affect the lump-sum tax T in equilibrium, the consumer takes T to be exogenous when choosing $\hat{\kappa}$. Notice that the optimization in equation (13) differs from that in equation (3) only in terms of the constraint. Thus, the first-order condition is of the same form as equation (6):¹⁴

$$(14) \quad \int \alpha q dF(\theta) = -\bar{\alpha}\hat{P}'(\hat{\kappa}).$$

From equation (11) the premium derivative is:

$$(15) \quad \hat{P}'(\hat{\kappa}) = \frac{(1 - s)}{(1 - \sigma)} \left[-\bar{q} + (1 - \sigma - \hat{\kappa}) \frac{d\bar{q}}{d\hat{\kappa}} \right],$$

where $d\bar{q}/d\hat{\kappa}$ is again the net derivative of \bar{q} with respect to $\hat{\kappa}$, including the effect on \bar{q} of any induced change in the premium. The first-order condition is thus

$$(16) \quad \text{cov}(q, \alpha) = -\bar{\alpha} \left[\bar{q} \frac{(s - \sigma)}{1 - \sigma} + (1 - s) \times \left(1 - \frac{\hat{\kappa}}{(1 - \sigma)}\right) \frac{d\bar{q}}{d\hat{\kappa}} \right].$$

This equation can be interpreted in a similar fashion to the first-order condition in the subsidy-free case. The consumer chooses $\hat{\kappa}$ to balance the marginal cost of additional risk, measured as before by the covariance between q and α , against the utility gains associated with the reduction in the expected cost of health. As is clear from the right-hand side of equation (16), a change in $\hat{\kappa}$ affects these

¹⁴ Although as written, this first-order condition is identical to that of the subsidy-free case, the equilibrium contract is different. This is due to the fact that since the constraint of the problem, equation (11), includes the subsidy variables, so does the premium derivative in equation (15). Dowd and Feldman (1987) overlooked this point in concluding that full deductibility of health care expenses would lead to the same premium choice as in the tax-free case.

utility gains in two ways. First, holding the quantity of health in each state of the world constant, an increase of $d\hat{\kappa}$ in the coinsurance rate increases the consumer's out-of-pocket costs by $q d\hat{\kappa}$ in each state of the world, but reduces the premium by $((1-s)/(1-\sigma)) \bar{q} d\hat{\kappa}$. The average net effect is $((s-\sigma)/(1-\sigma)) \bar{q} d\hat{\kappa}$, the first term on the right-hand side, which can be thought of as a composition effect.¹⁵ When s is greater than σ , increasing the coinsurance rate increases the consumer's expected health costs because the insurance contract becomes less weighted towards the more subsidized form of payment for health. When σ is greater than s , however, increasing the coinsurance rate saves money.

Second, the net effect on welfare of changes in q induced by a change in the coinsurance rate is again measured by the utility value of the change in the premium, which is reflected in the second term on the right-hand side of equation (16).

III. Effects of Subsidies on Health Expenditures and Welfare

We use condition (16) to prove our main results. These are that: (i) providing premium subsidies leads to reduced coinsurance rates and higher health expenditures; (ii) providing subsidies to coinsurance can, under certain conditions, lead to higher effective coinsurance rates and lower health expenditures; and (iii) the effects of the premium subsidy on the coinsurance rate can be "undone," and the subsidy-free insurance contract replicated, with an appropriately chosen coinsurance subsidy. The rate of coinsurance subsidy necessary to undo the effects of a premium subsidy completely generally is higher than the rate of premium subsidy. If welfare is monotonically decreasing in deviations of health expenditures from the subsidy-free optimum, then our results also imply that subsidies to premiums are welfare reducing, but that in the presence

¹⁵ Recall that in the subsidy-free case, the net effect of a change in the coinsurance rate on expected health expenditures, holding q constant in each state of the world, is zero.

of premium subsidies, coinsurance subsidies can be welfare improving.

In order to prove these results, we first note that in equilibrium, the consumer's net after-tax income depends only on the effective coinsurance rate and average health expenditures, because the lump-sum tax removes any direct benefit from the premium and coinsurance subsidies. This is established by the following result.

LEMMA: *When lump-sum taxes are used to finance health subsidies, income net of the premium and taxes is not a direct function of the subsidy rates.*

PROOF:

The financing requirement is $T = sP + \sigma\kappa\bar{q}$. Thus, income net of the premium and taxes is

$$\begin{aligned} (17) \quad \hat{W} - \hat{P} &= W - P(1-s) - T \\ &= W - P - \sigma\kappa\bar{q} \\ &= W - (1-\kappa)\bar{q} - \sigma\kappa\bar{q} \\ &= W - (1-\hat{\kappa})\bar{q}. \end{aligned}$$

A. Effect of Premium Subsidies

Subsidizing health insurance premiums affects the choice of the optimal coinsurance rate in two ways. First, the subsidy reduces the private cost of moral hazard, since the consumer only pays $(1-s)$ of any increase in health insurance premium associated with a reduction in $\hat{\kappa}$. Second, holding q constant, the subsidy provides an incentive for consumers to shift their form of health payments away from coinsurance and toward premiums, in order to receive higher net subsidy payments. Both of these effects encourage consumers to choose a lower rate of coinsurance and a higher level of health expenditures than they would in the subsidy-free case. This result is in accordance with the traditional view of the effects of health insurance premium subsidies.

The result is proved formally in the following proposition. Define $\hat{\kappa}^*(s, \sigma)$ as the consumer's optimal after-tax rate of coinsurance given s and σ , and $\bar{q}(s, \sigma)$ as the average

chosen health expenditures given s , σ and $\hat{k}^*(s, \sigma)$.

PROPOSITION 1: *For any σ and s , $(\partial \hat{k}^*/\partial s)(s, \sigma) < 0$. If $d\bar{q}/d\hat{k} < 0$, then $(\partial \bar{q}/\partial s)(s, \sigma) > 0$.*

PROOF:

Totally differentiating the first-order condition (16) with respect to \hat{k} and s , and using the lemma,¹⁶ gives

$$(18) \quad \frac{\partial^2 \Psi}{\partial \hat{k}^2} d\hat{k}^* \\ = \bar{\alpha} \left[\frac{\bar{q}}{(1-\sigma)} - \left(1 - \frac{\hat{k}}{(1-\sigma)} \right) \right. \\ \left. \times d\bar{q}/d\hat{k} \right] ds.$$

Assuming that the first-order condition defines a maximum, the term on the left-hand side of this expression is negative.¹⁷ Using equation (16), the coefficient of ds is

$$(19) \quad \bar{\alpha} \left[\frac{\bar{q}}{(1-\sigma)} - \left(1 - \frac{\hat{k}}{(1-\sigma)} \right) d\bar{q}/d\hat{k} \right] \\ = \frac{1}{(1-s)} \int \alpha q dF(\theta).$$

Since q and α are both positive for all θ , the coefficient on ds is positive as long as $s < 1$, so $(\partial \hat{k}^*/\partial s)(s, \sigma) < 0$. Clearly, if it is further assumed that $d\bar{q}/d\hat{k} < 0$, then health expenditures increase with s .

B. Effect of Coinsurance Subsidies

The consumer chooses \hat{k} just to balance the cost of a marginal increase in risk against the net benefits of a reduction in the expected cost of health. At a particular \hat{k} , a coinsurance sub-

sidy has no impact on the increase in risk attributable to an increase in \hat{k} . Thus, the risk effect is unchanged by the subsidy, and the effect of the coinsurance subsidy on the choice of \hat{k} depends solely on whether it increases or decreases the expected savings resulting from an increase in \hat{k} .

Unlike the premium subsidy, the subsidy to coinsurance has ambiguous effects on the net savings associated with an increase in \hat{k} . Like the premium subsidy, the coinsurance subsidy reduces the responsiveness of the premium to a change in health consumption. At any given effective coinsurance rate, \hat{k} , the share of any increase in utilization paid by the consumer is fixed (regardless of the coinsurance subsidy). But the higher the coinsurance subsidy, the greater the share paid for by the government, and hence the lower the insurance company's share. Thus, the higher the coinsurance subsidy, the lower the increase in the premium associated with an increase in utilization. Similarly, when utilization falls, the premium does not decrease by as much. The private cost of moral hazard is effectively reduced with a coinsurance subsidy, encouraging the consumer to choose a low coinsurance rate.

On the other hand, subsidizing coinsurance payments encourages consumers to tilt the composition of health spending away from premiums and toward coinsurance. Holding q constant in all states of the world, an increase in \hat{k} reduces the share of health expenditures paid for in the form of a premium, and increases the share paid for in the form of coinsurance. The higher the subsidy provided to coinsurance, the more this composition effect will induce the consumer to choose a high coinsurance rate.

Which of these effects dominates depends upon the net elasticity of demand for health. As discussed above, the coinsurance subsidy will induce the consumer to increase \hat{k} only if the expected savings resulting from such an increase are larger in the presence of the coinsurance subsidy. This in turn depends only on whether the total coinsurance subsidy provided by the government increases with the coinsurance rate. The total expected coinsurance subsidy is equal to $\sigma \kappa \bar{q} = (\sigma/(1-\sigma)) \hat{k} \bar{q}$. If total demand is inelastic, then

¹⁶ The lemma shows that s and σ affect q only through the choice of \hat{k} .

¹⁷ The first-order condition can be written $\partial \Psi / \partial \hat{k} = -\int \alpha q dF - \bar{\alpha} \hat{P}'(\hat{k}) = 0$.

increasing \hat{k} will lead to an increase in $\hat{k}\bar{q}$, and thus in the coinsurance subsidy. Under this condition, providing a subsidy to coinsurance payments will lead to an increase in the effective rate of coinsurance and, assuming that total demand is downward sloping, to a reduction in consumption of health services. To prove this formally, first define the net elasticity of demand as $\varepsilon \equiv -(\hat{k}/\bar{q})(d\bar{q}/d\hat{k})$, which includes the effects of premium changes on the demand for health.

PROPOSITION 2: *For any σ and s , if $\varepsilon < 1$, then $(\partial\hat{k}^*/\partial\sigma)(s, \sigma) > 0$. If $d\bar{q}/d\hat{k} < 0$, then $(\partial\bar{q}/\partial\sigma)(s, \sigma) < 0$.*

PROOF:

Totally differentiating the first-order condition (16) with respect to \hat{k} and σ , and using the lemma, gives

$$(20) \quad \frac{\partial^2\Psi}{\partial\hat{k}^2} d\hat{k}^* + \bar{\alpha} \frac{(1-s)}{(1-\sigma)^2} \times [\bar{q} + \hat{k}d\bar{q}/d\hat{k}]d\sigma = 0$$

and the coefficient of $d\sigma$ can be rearranged as

$$(21) \quad \bar{\alpha} \frac{1-s}{(1-\sigma)^2} \bar{q}(1-\varepsilon) > 0.$$

Clearly, if it is further assumed that $d\bar{q}/d\hat{k} < 0$, then health expenditures decrease with σ .

Joseph P. Newhouse (1993) reports that the estimates of the price elasticity of demand defined in the standard fashion—that is, holding the premium constant—derived from the RAND experiments were all significantly less than one. In Appendix Proposition A3, we show that if the elasticity of average demand defined in the standard way is less than one, then the net elasticity of demand also will be less than one.

C. The Optimal Coinsurance Subsidy

In this section we examine the conditions under which, given a subsidy to premiums, it is possible to subsidize out-of-pocket costs at such a rate so as to induce the individual to

choose the subsidy-free optimal effective insurance contract. We also show that the coinsurance subsidy that yields this contract is greater than the existing subsidy to premiums. Again, an examination of the first-order condition in equation (16) provides simple intuition for this result. When equal subsidies are provided to both premiums and coinsurance, the choice of the coinsurance rate does not affect the cost of health expenses for any given level of q ; that is, there is no composition effect, and the first term on the right-hand side of equation (16) is zero. However, the effect from the second term on the right-hand side of equation (16) remains: moral hazard still is cheaper than without subsidies. Thus, being indifferent between coinsurance and premiums to pay for any given level of q is not enough to restore the subsidy-free coinsurance choice. In order for the consumer to choose the subsidy-free \hat{k} , the coinsurance subsidy must be increased so that the positive composition effect is large enough to offset the effect of the reduced moral hazard cost. This is proven formally below. As a corollary, we also show that, under the conditions of the proposition, uniform deductibility of all health expenses is preferred to deductibility of only health insurance premiums.

PROPOSITION 3: *For any s , if $d\bar{q}/d\hat{k} < 0$ and $\varepsilon < 1$, there exists a subsidy to coinsurance, $\sigma^*(s) > s$, such that $\hat{k}^*(s, \sigma^*(s)) = \hat{k}^*(0, 0)$ and $\bar{q}(s, \sigma^*(s)) = \bar{q}(0, 0)$.*

PROOF:

For a fixed value of s , we search for the value of σ that yields identical first-order conditions in both the subsidized and subsidy-free cases. In each case, the first-order condition can be written

$$(22) \quad \text{cov}(q, \alpha) = -\bar{\alpha}(\hat{P}'(\hat{k}) + \bar{q}).$$

By the lemma, income net of premium and taxes, and prices, are the same in the two cases, so the first-order conditions are identical with and without subsidies if, and only if, with obvious notation

$$(23) \quad \hat{P}'_{0,0}(\hat{k}) = \hat{P}'_{s,\sigma}(\hat{k}),$$

which implies, using equations (7) and (15),¹⁸ that

$$(24) \quad (1 - \hat{\kappa}) \frac{d\bar{q}}{d\hat{\kappa}} - \bar{q} = (1 - s) \left(1 - \frac{\hat{\kappa}}{(1 - \sigma)} \right) \frac{d\bar{q}}{d\hat{\kappa}} - \frac{1 - s}{1 - \sigma} \bar{q}.$$

With some manipulation,¹⁹ this can be rearranged as

$$(25) \quad \frac{\sigma/1 - \sigma}{s/1 - s} = 1 - \frac{d\bar{q}/d\hat{\kappa}}{\bar{q}(1 - \varepsilon)}.$$

Thus, under the conditions of the proposition, $\sigma^*(s) > s$.

COROLLARY: *If $d\bar{q}/d\hat{\kappa} < 0$ and $\varepsilon < 1$, then $\hat{\kappa}^*(s, s) > \hat{\kappa}^*(s, 0)$ and $\bar{q}(s, s) < \bar{q}(s, 0)$.*

¹⁸ Since $d\bar{q}/d\hat{\kappa} = \bar{q}_{\hat{\kappa}} - \bar{q}_{\sigma} \hat{P}'(\hat{\kappa})$ and the $\hat{P}'(\hat{\kappa})s$ are equal, $d\bar{q}/d\hat{\kappa}|_s, \sigma = d\bar{q}/d\hat{\kappa}|_0, 0$.

¹⁹ Rearrange (24) as

$$(1 - \hat{\kappa}) \frac{d\bar{q}}{d\hat{\kappa}} - \bar{q} = (1 - s) \left[\left((1 - \hat{\kappa}) \frac{d\bar{q}}{d\hat{\kappa}} - \bar{q} \right) - \frac{\sigma}{(1 - \sigma)} \left(\hat{\kappa} \frac{d\bar{q}}{d\hat{\kappa}} + \bar{q} \right) \right]$$

or

$$\left(\frac{d\bar{q}}{d\hat{\kappa}} - \left(\hat{\kappa} \frac{d\bar{q}}{d\hat{\kappa}} + \bar{q} \right) \right) \left(\frac{1}{1 - s} - 1 \right) = - \frac{\sigma}{1 - \sigma} \left(\hat{\kappa} \frac{d\bar{q}}{d\hat{\kappa}} + \bar{q} \right).$$

Substituting $\varepsilon = -\hat{\kappa}/\bar{q}(d\bar{q}/d\hat{\kappa})$ yields equation (25) in the text.

PROOF:

Proposition 2 shows that for a given s , $\hat{\kappa}^*(s, \sigma)$ is monotonically increasing in σ , which proves the first property. Since expenditures are decreasing in $\hat{\kappa}$, the second property follows.

IV. Numerical Simulations

We have shown that, under certain conditions, providing a sizeable subsidy to coinsurance payments will increase the chosen coinsurance rate and reduce health expenditures to the levels obtained when health expenditures are unsubsidized. As long as welfare is monotonically decreasing in deviations of health expenditures from the first-best optimum then, under our assumptions, any coinsurance subsidy less than or equal to the optimal one will be welfare improving.

In this section, we report the results from numerical simulations of our model. These simulations allow us to examine the magnitude of the subsidies likely to be required in practice. Furthermore, they allow us to examine, in a simple way, how the optimal coinsurance subsidy changes if the taxes required to finance the subsidies are distortionary rather than lump sum.²⁰ In the presence of dead-weight loss, it is not possible to fully undo the welfare losses of the premium subsidy with an appropriately chosen coinsurance subsidy. Nevertheless, some subsidy to coinsurance will likely be desirable.

For our simulations, we use a constant elasticity of substitution (CES) utility function of the form

$$(26) \quad U(C, H) = \frac{1}{1 - \xi} (\eta H^\rho + (1 - \eta) C^\rho)^{(1 - \xi)/\rho},$$

²⁰ Although uniform lump-sum taxes are regressive and thus politically unacceptable, it is possible that tax subsidies to coinsurance could be financed with lump-sum taxes without significant distributional consequences. Since coinsurance payments as a fraction of income are likely to be highest for the middle class, financing the subsidies with a change in the personal exemption, for example, might roughly preserve the current distribution of the tax burden.

where ξ is the coefficient of relative risk aversion (CRRA), and ρ is the elasticity of substitution between consumption of health and other goods. We normalize income, W , to be 100. We assume that the tax rate is 20 percent and the employer and employee shares of the payroll tax are each 7.65 percent. These parameters yield a value for s of 32.8 percent.²¹ The price elasticity of demand for medical services has been estimated to be between 0.1 to 0.3 (Newhouse, 1993 pp. 120–21). We choose values of ρ such that, when the rate of coinsurance is 20 percent, the average elasticity of demand is either 0.1, 0.2, or 0.3. We also run the simulations for three values for the coefficient of relative risk aversion, namely $\xi = 1.5, 3, \text{ and } 5$.

In general, we view this model as primarily a model of nonhospital services, since most health insurance contracts have a deductible, but no coinsurance, for hospital services. Thus, we calibrate the model such that the optimal choice of health expenditures under the current tax system (i.e., with only a premium subsidy) matches the mean and variance of nonhospital expenditures from the 1987 National Medical Expenditure Survey (NMES), updated to 1994 values. Using these data, we target health expenditures to be 6.3 percent of income, and the ratio of the variance to the mean squared to be 5.7.²² As described above, we model shocks to health status as shocks to the price of health, θ . Newhouse (1993) shows that the distribution of medical expenditures is bimodal. A significant fraction of the population has zero expenditures, while the distribution of nonzero expenditures is approximately lognormal. Thus, we choose values of the random variable θ from a lognormal distribution, and append a certain fraction (16

percent) of very small values for θ (since θ is our price variable, it cannot be zero in this model).²³ In order to reach the mean and variance targets for the distribution of observed health expenditures, we need to change the parameters (mean and variance) of the distribution of the unobserved variable, θ , for each set of risk aversion and demand elasticity parameters.²⁴

We examine the effects of distortionary financing with a simple “deadweight loss factor,” representing the real cost of one dollar of tax revenue. Edgar K. Browning (1987) and Charles L. Ballard et al. (1985) conclude that the marginal welfare cost of an additional dollar of tax revenue is likely to be in the range of 15 to 50 percent. For our simulations, we use a relatively high value of 40 percent. In particular, we assume that taxes are equal to 1.4 times the amount necessary to actually fund the subsidies, and assume that the extra tax revenues simply are discarded.

We examine the optimal coinsurance rate, total health spending, premium, and total taxes under five tax structures:

- (i) no subsidies to health expenditures: $s = 0, \sigma = 0$;
- (ii) the current tax structure: $s = 0.328, \sigma = 0$,²⁵
- (iii) equal subsidies to premiums and coinsurance: $s = \sigma = 0.328$;
- (iv) the optimal subsidy to coinsurance σ^* given the current premium subsidy, and given no deadweight loss; and

²³ It is clear that a lognormal distribution of prices will not necessarily generate a lognormal distribution of medical expenditures. However, because we only target the first two moments of the distribution of expenditures, the convenient two-parameter, lognormal function is used to describe the distribution of prices.

²⁴ For example, as the elasticity of demand increases, the variance and mean of health expenditures resulting from any given set of θ 's decrease. Thus, to reach the mean and variance targets for health expenditures, we increase the mean and variance of the distribution of θ as the elasticity of demand increases.

²⁵ We ignore the fact that some coinsurance currently is paid with pretax dollars through the use of flexible spending arrangements, and also that the employee's share of the health insurance premium generally is paid for with after-tax dollars.

²¹ When an employer spends an additional dollar on employee compensation in the form of wages, the cash wage paid is $1/1.0765$, and the employee receives $(1 - 0.2 - 0.0765)/1.0765 = 1 - 0.328$.

²² In particular, we look at the distribution of all medical costs, excluding hospital facility charges, and also excluding dental and vision expenses, which generally are not covered by health insurance. We examine the distribution of these costs on a health insurance unit (like a family) basis, and exclude all individuals aged 65 or older.

TABLE 1—SIMULATION RESULTS (DEMAND ELASTICITY = 0.2; COEFFICIENT OF RELATIVE RISK AVERSION = 3)

Subsidy parameters	Effective coinsurance rate $\hat{\kappa}$	Contractual coinsurance rate κ	Average health expenditure \bar{q}	Total taxes T	EV as a percentage of current health spending EV/\bar{q}	EV_{DWL} as a percentage of current health spending EV_{DWL}/\bar{q}
$s = 0, \sigma = 0$	0.33	0.33	5.6	0.00	0.0	0.0
$s = 0.328, \sigma = 0$	0.20	0.20	6.3	1.63	3.7	14.3
$s = \sigma = 0.328$	0.26	0.39	6.0	1.96	1.1	13.7
$s = 0.328, \sigma = \sigma^* = 0.50$	0.33	0.49	5.6	2.46	0.0	15.7
$s = 0.328, \sigma = \sigma_{DWL}^* = 0.29$	0.25	0.35	6.0	1.90	1.4	13.6

(v) the optimal subsidy to coinsurance σ_{DWL}^* given the current premium subsidy, and given a deadweight loss factor of 40 percent.

We evaluate the welfare losses of the subsidies in cases (ii) – (v) by the equivalent variation (EV), the amount of money that could be taken away in the no-subsidy case while leaving individuals equally well off, with and without deadweight loss.

The results for the basic simulation with intermediate values of 0.2 for the elasticity of demand and 3 for the coefficient of relative risk aversion are presented in Table 1. We report the effect coinsurance rate $\hat{\kappa}$, the contractual coinsurance rate κ , the average amount of health spending \bar{q} , taxes T , the equivalent variation as a fraction of baseline health spending (i.e., 6.3) EV/\bar{q} , and the equivalent variation when there is deadweight loss associated with taxation (EV_{DWL})/ \bar{q} . Under a subsidy-free regime, when $s = 0$ and $\sigma = 0$, the coinsurance rate would be 33 percent, and health spending would only be 5.6. In contrast, under the current tax regime ($s = 0.328, \sigma = 0$), the chosen coinsurance rate is only 20 percent, which matches the modal coinsurance rate actually observed in private health insurance contracts (Jon Gabel et al., 1994). Providing a subsidy to health insurance premiums reduces the chosen rate of coinsurance by almost 40 percent, and increases health expenditures by roughly 10 percent. The welfare loss from the premium

subsidy, as measured by the EV , is 3.7 percent of health spending, and roughly 0.2 percent of income. Including a measure of deadweight loss from taxes needed to finance the premium subsidy more than triples the measure of welfare loss, to over 14 percent of health spending, or almost 1 percent of income.²⁶ If the subsidy to coinsurance was made equal to that provided to premiums, the chosen effective rate of coinsurance would increase to 26 percent, and health spending would fall to 6.0. This tax change would reduce the welfare loss, under the assumption of no deadweight loss, by 2.6 percent of health spending. When deadweight loss is taken into account, the welfare gains of this policy relative to current distortionary tax policy are reduced to 0.6 percent of health spending.

The optimal subsidy to coinsurance, ignoring deadweight loss, is 50 percent. Providing this subsidy to coinsurance completely undoes the negative effects of the premium subsidy, bringing the effective coinsurance and health spending to the subsidy-free levels. However, when deadweight loss is taken into account,

²⁶ In the table, we do not present separate results for the coinsurance, health spending, etc., under deadweight loss. Because taxes are taken as exogenous, deadweight loss does not affect the choice of the coinsurance, and so does not affect the share of income devoted to health versus other goods. However, the existence of deadweight loss reduces the total amount of consumption, so spending on health would be lower than that presented in the table.

TABLE 2—OPTIMAL RATES OF COINSURANCE UNDER ALTERNATE PARAMETERS

Demand elasticity	Coefficient of relative risk aversion					
	1.5		3		5	
	No subsidies	Current subsidies	No subsidies	Current subsidies	No subsidies	Current subsidies
0.1	65	22	31	15	19	12
0.2	67	30	33	20	21	15
0.3	67	35	34	22	21	17

increasing the subsidy from 32.8 percent to 50 percent actually reduces welfare. Indeed, as shown in the last row of the first panel of Table 1, the optimal σ when deadweight loss is taken into account is 29 percent, very close to the 32.8-percent premium subsidy. This subsidy brings the coinsurance rate up to 25 percent and health expenditures down to 6.0.

We performed simulations with the coefficient of relative risk aversion between 1.5 and 5, and with demand elasticities ranging between 0.1 and 0.3. When there is no deadweight loss from financing the coinsurance and premium subsidies, optimal coinsurance subsidies increase welfare by between 2.2 percent and 7.5 percent of baseline health spending, depending mostly on the coefficient of relative risk aversion. Since, when there is no deadweight loss associated with financing the subsidies, the optimal coinsurance subsidy completely removes the welfare loss caused by the premium subsidy, these numbers also are a measure of the welfare loss produced by the current tax structure. The optimal coinsurance subsidy when there is no deadweight loss ranges from 41 to 62 percent. If the subsidies are financed with distortionary taxes, subsidizing coinsurance becomes significantly less valuable, although with all but one set of parameters (elasticity of 0.3 and CRRRA of 5), it is a welfare-improving policy. Welfare gains range from 0 to 5.4 percent of health spending, and the optimal coinsurance subsidy ranges from 0 to 35 percent.²⁷ Table 2 shows the ef-

fect of the current tax structure on coinsurance rates, and since the difference between the coinsurance rates under the subsidy-free and the current premium-subsidy regimes is higher for low values of risk aversion and low demand elasticities, the benefits of removing the distortion are higher as well.

V. Conclusions

If health insurance premiums are payable with pretax dollars, then our model implies that under reasonable assumptions subsidizing coinsurance payments will reduce health expenditures and increase welfare. Ignoring deadweight loss, we show that the optimal subsidy to coinsurance is higher than that provided to premiums, but that equal subsidies to coinsurance and premiums still will be welfare improving. In the presence of deadweight loss, equal subsidies may be close to optimal. One limitation of our analysis is that insurance contracts are constrained to consist of a single rate of coinsurance and premium, while in practice, insurance contracts generally include deductibles and maximum out-of-pocket payments. Although an analysis of these nonlinearities in the budget constraints is beyond the scope of this paper, it is likely that our general result still would hold: subsidizing out-of-pocket expenditures would increase the propensity of consumers to choose health insurance contracts with higher deductibles, higher levels

²⁷ We have assumed throughout that prices of medical care (i.e., the θ 's) are exogenous. As noted by Feldstein and Friedman (1977) and Feldman and Dowd (1991), if the low coinsurance rate induced by the current tax struc-

ture also leads to a higher rate of medical cost increase, then the welfare loss is significantly greater. In this case, the presence of deadweight loss from financing the subsidies would be much less important.

of coinsurance, and higher out-of-pocket payments.²⁸

APPENDIX

PROPOSITION A1: *If q is increasing with θ , then $\text{cov}(q, \alpha) > 0$ as long as α is increasing in θ . This requires that the coefficient of relative risk aversion, ξ , be sufficiently large. In particular, ξ must be larger than the income elasticity of demand for health.*

PROOF:

We show that α is increasing in θ under the assumption on ξ . Using Roy's identity, write

$$\begin{aligned}
 \text{(A1)} \quad \frac{d\alpha}{dp} &= \frac{\partial}{\partial p} V_m(p, m) \\
 &= \frac{\partial}{\partial m} V_p(p, m) \\
 &= -\frac{\partial}{\partial m} (HV_m) \\
 &= -V_{mm}H - V_m \frac{\partial H}{\partial m} \\
 &= \frac{V_m H}{m} (\xi - \varepsilon_m),
 \end{aligned}$$

²⁸ The same intuition should apply: A tax structure that subsidizes premiums, but not out-of-pocket payments, would cause consumers to tilt the form of their insurance away from deductibles and coinsurance, and toward low out-of-pocket maximums. Providing a subsidy to all forms of out-of-pocket payments would likely lead to a net increase in the share of health expenditures financed by out-of-pocket payments. For example, to completely undo the effects of providing a 50-percent subsidy to out-of-pocket payments, the insurance contract would have to double the contractual deductible (such that the individual paid 200 percent of the first D dollars of health expenditures, where D is the initial deductible amount), double the contractual coinsurance rate, and double the out-of-pocket maximum. Such a change in the insurance contract would leave the effective price of health unchanged. The subsidy to out-of-pocket payments should then induce the consumer to take more risk through some combination of higher deductibles, higher coinsurance, and higher out-of-pocket maximums. The effect of such a subsidy would likely be to reduce health expenditures and increase welfare.

where $\xi = -mV_{mm}/V_m$ and $\varepsilon_m = (m/H)(dH/dm)$. Hence the result.

The penultimate line of (A1) provides the clearest intuition for this condition. The first term represents an income effect—a small increase in the price dp lowers income by Hdp , which affects the marginal utility of income in the obvious way. However, when the price of H is higher, the marginal utility of an extra dollar is reduced because of its lower purchasing power. In particular at the higher price $p + dp$, an extra dollar increases health by dH at a cost $(p + dp)dH$, and other consumption by dC , where $dC + (p + dp)dH = 1$. At the original price of health, the same increase in H and C could have been effected by the transfer of just $dC + pdH = 1 - dpdH$, to a first order. The value of such a transfer in the lower price state is just $V_m(1 - dpdH)$, so the marginal utility of income falls, due to the substitution effect, by $V_m dpdH$, corresponding to the second term of the penultimate line of (A1).

When indifference curves are described by the CES utility function (as in Section IV of the text), then the income elasticity of demand for health is unity, and the condition for the individual to be risk averse enough is that the coefficient of relative risk aversion be greater than one.

PROPOSITION A2: *Define the elasticity of average demand for health by $\bar{\varepsilon} = -(\hat{\kappa}/\bar{q})\bar{q}_{\hat{\kappa}}$. For all σ and s , if $((1-s)/(1-\sigma))\hat{\kappa}\bar{q}_m < \bar{\varepsilon} < 1$, then $d\bar{q}/d\hat{\kappa} < 0$.*

PROOF:

Note that since $\bar{q} = \bar{q}(\hat{\kappa}\theta, \hat{W} - \hat{P})$ and $\hat{P} = (1-s)(1-\hat{\kappa}/(1-\sigma))\bar{q}$, the net demand derivative is

$$\begin{aligned}
 \text{(A2)} \quad \frac{d\bar{q}}{d\hat{\kappa}} &= \frac{\bar{q}_{\hat{\kappa}} + \frac{(1-s)}{(1-\sigma)}\bar{q}\bar{q}_m}{1 + (1-\kappa)(1-s)\bar{q}_m} \\
 &= \frac{-\frac{\bar{q}}{\hat{\kappa}} \left(\bar{\varepsilon} - \bar{q}_m \hat{\kappa} \frac{(1-s)}{(1-\sigma)} \right)}{1 + (1-\kappa)(1-s)\bar{q}_m}.
 \end{aligned}$$

Under the condition of the proposition, the numerator is negative. If $\kappa < 1$, then the denominator is positive, and the result follows. Alternatively, if $\kappa > 1$, then again by the first inequality of the proposition, the denominator is at least as large as $1 + (1 - \kappa)\bar{\varepsilon}/\kappa = [\kappa(1 - \bar{\varepsilon}) + \bar{\varepsilon}]/\kappa$, which is positive when $\bar{\varepsilon} < 1$.

COROLLARY A1: *If $\text{cov}(q, q_m)/\bar{q}\bar{q}_m > (\sigma - s)/(1 - \sigma)$ and $\bar{\varepsilon} < 1$, then $d\bar{q}/d\hat{\kappa} < 0$.*

PROOF:

Using the Slutsky equation,

$$(A3) \quad \bar{q}_{\hat{\kappa}} + \frac{(1-s)}{(1-\sigma)} \bar{q}\bar{q}_m \\ = \bar{q}_{\hat{\kappa}}^{\varepsilon} - \left(\text{cov}(q, q_m) - \frac{(\sigma-s)}{(1-\sigma)} \bar{q}\bar{q}_m \right),$$

where $\bar{q}_{\hat{\kappa}}^{\varepsilon}$ is the compensated demand derivative, which is negative. Under the first condition of the corollary, this expression is thus negative. This, coupled with the second condition, ensures that the conditions of Proposition A2 are satisfied.

Note that when $\sigma < s$, the corollary requires only that the covariance between q and q_m be positive. Since it is assumed that for a given coinsurance rate q is increasing in θ , such a positive covariance requires that on average q_m also is higher for individuals with greater health needs. That is, sicker individuals spend more on health, and spend more of an additional dollar of income on health also. As σ becomes increasingly larger than s , the normalized covariance must be sufficiently positive (for a given compensated derivative) for the net derivative $d\bar{q}/d\hat{\kappa}$ to be negative.

COROLLARY A2: *If $\bar{\varepsilon} < 1$ and $\hat{\kappa}^*(0, 0) < 1$, then $d\bar{q}/d\hat{\kappa} < 0$ if $\sigma < \sigma^*(s)$ and $\sigma < 1 - (1-s)\bar{q}_m/\bar{\varepsilon}$.*

PROOF:

Since $\hat{\kappa}(s, \sigma) < \hat{\kappa}^*(0, 0) < 1$ for all $\sigma < \sigma^*$, then $\bar{\varepsilon} - ((1-s)/(1-\sigma))\hat{\kappa}\bar{q}_m > \bar{\varepsilon} - ((1-s)/(1-\sigma))\bar{q}_m > 0$.

Applying Proposition A2 thus yields the result.

Note that $\bar{q}_m = \varepsilon_m(\bar{q}/m) = \varepsilon_m\eta$, where ε_m is the income elasticity of demand for health, and η is the income share of health. Using a value of 0.06 for η , and values from Newhouse (1993) of 0.2 for the price elasticity and 0.3 for the income elasticity of demand, Corollary A2 shows that the net derivative of demand is negative for values of $\sigma < 0.94$.

PROPOSITION A3: *If $\bar{\varepsilon} < 1$, then assuming the existence of an interior optimum, the net elasticity of demand, ε , also is less than one.*

PROOF:

The net elasticity of demand is $\varepsilon = -\hat{\kappa}/\bar{q}(d\bar{q}/d\hat{\kappa}) = (-\hat{\kappa}/\bar{q})\bar{q}_{\hat{\kappa}} + (\hat{\kappa}/\bar{q})\bar{q}_m\hat{P}'(\hat{\kappa})$, which can be expressed as $\bar{\varepsilon} + (\hat{\kappa}/\bar{q}) \times \bar{q}_m\hat{P}'(\hat{\kappa})$. From equation (14) it is clear that at an interior optimum the second term is negative, because $P'(\kappa) < 0$ at such a point. Thus, $\varepsilon < \bar{\varepsilon} < 1$.

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