Demand for Supplementary Health Insurance

M. Susan Marquis, Charles E. Phelps

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PREFACE

Many current proposals aimed at encouraging competition in the health sector call for changes in the way employer-paid health insurance premiums are treated for tax purposes, and for a multiple choice of health insurance plans. This report presents an empirical analysis of the demand for supplementary health insurance and examines the potential effects of implementing these proposals. Extensive demand for supplementary insurance may dampen the effectiveness of catastrophic or major risk insurance proposals intended to increase patient cost sharing; the analysis provides estimates of the size of this demand. The authors do not investigate whether the insurance market has an equilibrium; subsequent work will address that issue.

This research was performed as part of the Rand Health Insurance Experiment under Grant 016B-80 from the U.S. Department of Health and Human Services. It should be of interest to decisionmakers who formulate health policy and to the health research community. An earlier version of this report was presented as a paper at the American Economic Association meetings, December 28, 1982, in New York City.

SUMMARY

Rising health care costs have been a major health policy issue for several decades. Two common features in many proposals to stem the rising costs are a change in the way employer-paid health insurance premiums are treated for tax purposes and a requirement that employers offer choices among health benefit plans. This research investigates some impacts of these proposals.

Our statistical analysis is based on families' responses to hypothetical offers to purchase supplementary insurance coverage. Families in our sample were participants in the Rand Health Insurance Experiment (HIE), a controlled trial to study the effects of cost sharing in health insurance. During participation in the HIE, families were randomly assigned to insurance plans with varying cost-sharing requirements. The hypothetical insurance policies offered would reduce the level of cost sharing.

The current tax-favored status of employer contributions to employee health insurance premiums is believed by many to lead consumers to "overinsure." Eliminating the tax subsidy, and thereby raising the price of insurance, is advocated as a way of encouraging consumers to purchase insurance with a greater degree of cost sharing which, in turn, would reduce expenditures for medical care. Our results confirmed that the demand for insurance falls as its price increases. Using the estimated price response to simulate the demand for full supplementary coverage with and without the tax-favored treatment of insurance premiums, we estimated that the percentage of families demanding full coverage would fall by about 20 percentage points if premiums were treated as taxable income.

The response of the demand for health insurance to changes in the price of medical care was also investigated. Although it has sometimes been asserted that rising medical prices lead to a demand for more complete insurance protection, our statistical analysis evidenced a reduced demand for supplementary insurance as medical prices increased.

Our results also suggest that the demand for supplementary insurance may be sufficiently large to dampen the cost containment potential of so-called catastrophic or major risk insurance proposals, even without a tax subsidy. Major risk insurance would require cost sharing up to a catastrophic threshold, and results from the HIE have demonstrated that expenditures by persons with major risk insurance are significantly below expenditures by persons with full coverage.

However, the estimates presented in this report suggest that 35 to 40 percent of families might attempt to purchase supplementary coverage, even absent present tax incentives to purchase generous coverage. This result assumes that the underlying plan is not the "payor of last resort." If the coinsurance or deductible of the underlying plan applied to unreimbursed expenses, the market for supplementary insurance would be eliminated.

On the other hand, our results also call into question the ability of supplementary insurance markets to sustain themselves. Families anticipating high medical expenditures in the next year were more likely to express interest in purchasing supplementary coverage than other families. Furthermore, easily observable demographic characteristics were not sufficient to distinguish risk classes and thereby eliminate the problem. This adverse selection may lead to a premium-adjusting spiral with the result that the market for supplementary insurance disappears. Whether this might happen is a topic now under investigation.

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I. INTRODUCTION

Rising health care costs have been a national concern for two decades. Consequently, a variety of proposals have been offered to reform the health care market. Many of these seek to strengthen financial incentives for consumers to make cost-conscious purchase decisions.

Two consumer-oriented strategies have been advocated. One seeks to strengthen consumer incentives at the time of the medical care purchase decision through greater use of coinsurance and deductibles. The other approach is to encourage greater competition among prepaid provider groups.

Proponents of both strategies would restructure the tax treatment of health insurance premiums so that consumers face the full cost differential in choosing among more and less expensive insurance plans (Feldstein and Friedman, 1977; Enthoven, 1978). Increasing the price that consumers pay for more comprehensive and expensive insurance plans is expected to alter the demand for these plans. However, some argue that price is not an important factor in consumers' decisions about health insurance and so consumers would continue to purchase comprehensive coverage even at considerably higher prices (McClure, 1976; Conrad and Marmor, 1980).

Many proposals would also increase the number of health insurance options consumers face. Health insurance is most frequently purchased through employer groups that offer limited, if any, choice among plans. Offering consumers a greater number of alternatives, coupled with an elimination of the tax subsidy, would allow each consumer to weigh the benefits and full costs of alternative packages and to choose the one that best suits his individual needs and preferences. This, in turn, is expected to encourage cost-efficient behavior among insurance plans as they compete for consumers' business. However, increasing consumer choice raises the question of adverse selection: To what extent will individuals who anticipate few illnesses choose low benefit plans and individuals facing greater risks select the more generous plans?

Previous empirical work has addressed the importance of price and adverse selection in the demand for health insurance. These studies have suggested that the price of insurance is indeed an important determinant of demand (Phelps, 1976; Goldstein and Pauly, 1976; Taylor and Wilensky, 1983; Holmer, 1984), though the price elasticity

estimates from these studies span a wide range. The studies provide mixed findings about the importance of adverse selection (Phelps, 1976; Frech, 1976; Holmer, 1984). However, some of these studies have had to rely on imperfect proxy measures of price, such as work group size,[1] and of anticipated illness, such as prior illness or prior expenditures.

Furthermore, except for Holmer's study of plan choices by federal employees, previous studies have been based on observed insurance purchases by employees who had limited, if any, choice among plans. Consequently, it is difficult to generalize the findings to a market where private, rather than group, demands would be observed.[2]

To overcome some of these problems, we presented families participating in Rand's Health Insurance Experiment with hypothetical offers to purchase supplementary insurance to reduce their out-of-pocket payments. Our purpose here is to report our evidence concerning the effects of price, adverse selection, and other economic factors, on the demand for insurance based on these new data.

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[1]Because of significant economies in selling insurance to large groups, insurers offer discounts on premiums that increase with an increase in size of the contract. Thus, variation in work group size is systematically related to variation in the loading fee (the excess of premiums above expected benefits), with the loading fee varying from about 50 percent of expected benefits in small groups to 5 or 10 percent in large groups (Phelps, 1982). With information about the schedule of discounts, the estimated relationship between group size and insurance demand can be transformed to obtain an estimate of the relationship between the loading fee and demand. However, this method, used in the empirical work of Phelps and Goldstein and Pauly, is only approximate because of imperfect information about how loading fees vary with group size.

[2]Phelps (1973) used the subsample of families purchasing at least one nongroup insurance policy to estimate the "private demand curve." However, the population in the subsample may be self-selected and not representative of the entire population.

II. DATA

THE HEALTH INSURANCE EXPERIMENT

The Rand Health Insurance Experiment is a controlled trial to evaluate the effects of varying the generosity of insurance coverage. Details of the design of the study have been given elsewhere (Newhouse et al., 1981). Here we will note only a few of the central features of the study design.

Families participating in the study came from six sites—four metropolitan areas and two rural sites. About 70 percent of families participated for three years, the rest for five years. Families enrolled were representative of the population within the sites subject to a few restrictions: Families headed by persons age 62 or older were ineligible. The disabled eligible for Medicare were excluded as were persons eligible for the military medical care system and persons receiving Supplemental Security Income. Families with annual income exceeding $54,000 (1982 dollars) were ineligible; this rule excluded 3 percent of families initially contacted.

Families participating in the study were assigned to an experimental insurance plan. The plans varied on two dimensions: the coinsurance rate (the share of the bill the family paid), and an upper limit on annual out-of-pocket expenses.[1] The coinsurance rates were 0 (or free care), 25, 50, or 95 percent. The maximum out-of-pocket expenditure, also called the Maximum Dollar Expenditure (MDE), placed a limit on the risk a family faced in any one year. If the family's cost-sharing in a year equaled its MDE, any additional medical care used in that year was fully paid for by the insurance. There were three types of MDEs; two placed upper limits on the family's out-of-pocket expenditures, one limited an individual's out-of-pocket expenditures. The first type of family maximum was an income-related maximum, either 5, 10, or 15 percent of the family's income. Technically, all plans with a family maximum specified the upper limit as a percentage of income. However, there was also an absolute dollar limit on the size of the MDE, $750 for plans with 25 percent coinsurance, $1,000 for the other plans. Thus, for upper-, middle-, and high-income families, the MDE was a fixed family maximum that did not vary with income. Finally, in one

[1] An additional variation is that some families were assigned to a prepaid group practice; participants in the prepaid group are not included in the analysis discussed in this report.

experimental plan the maximum liability was a fixed dollar amount of \$150 for each family member, with an overall limit of \$450 for any family. In this plan the coinsurance rate was 95 percent, thus it approximated a plan with a \$150 per person deductible, and we called it the Individual Deductible Plan.[2]

THE HYPOTHETICAL SUPPLEMENTARY INSURANCE OFFERS

At the end of their participation in the study, each family, excepting families with free care, was presented with hypothetical offers to supplement (reduce the amount of) its MDE. The offers stipulated a premium that the family would have to pay for the supplemental insurance, and the family was asked whether it would buy the supplemental plan at the quoted premium. Each family was presented with hypothetical offers to reduce the maximum by one-third, by two-thirds, and by 100 percent (full coverage).[3] An algorithm was used to randomly generate premium quotes for each offer (see Appendix B). The responses to the hypothetical offers given by 1,326 families are the subject of this analysis.

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[2]In this plan only, the coinsurance rate applied only to outpatient care; inpatient care was fully covered by insurance.

[3]The questions are given in Appendix A. Questionnaires were sent to family heads, thus two sets of responses were received from families with two heads. The premiums quoted for the supplemental policy differed between two heads of a single family.

III. THE MODEL

Our interest centers on the effects of changes in the loading fee, the price of medical care, anticipated health expenditures, and income, on the probability that the family would purchase supplementary insurance. Phelps' (1973) theoretical investigation of the demand for insurance underlies our empirical investigation. Before turning to our empirical work, we summarize here the theoretical predictions about the effects of changes in the parameters of interest derived from Phelps' model (these results are developed in Appendix D).

The effect of changes in income on the desired level of the maximum depends on how absolute risk aversion varies with income. For a given maximum out-of-pocket limit in the base insurance policy, low-income families would be more likely than high-income families to express interest in purchasing a supplementary policy if risk aversion decreases with income, and less likely if risk aversion increases with income. Thus, we can infer how risk aversion varies with income based on the relationship between income and expressed preferences for supplementary insurance among families on a fixed maximum experimental plan.

The relationship between income and the demand for supplementary insurance is not as clear cut for the case in which the maximum is specified as a percentage of income and the supplementary plan reduces the percentage of income at risk. In this latter case, an increase in income increases the absolute dollar amount of the maximum. At a higher dollar maximum, the density of claims at the maximum is reduced, which in turn reduces the price of a supplementary policy. The total effect of an increase in income on the demand for supplementary insurance to reduce the percentage of income at risk consists of a pure income effect that depends on how risk aversion varies and a positive substitution effect stemming from the decrease in the price of supplementation as income increases.

The loading fee is the proportion by which the premium exceeds the actuarial value of the policy. An increase in the loading fee affects the demand for supplementary insurance in a way that is similar to the effects of an increase in the price of any product on the demand for that product. There is a substitution effect that reduces the demand for supplementary insurance and an income effect that depends on how risk aversion varies over income levels.

Increases in the price of medical care and increases in the coinsurance specified in the base policy have a similar effect on the demand for supplementary insurance. The price rise introduces an income effect dependent upon how risk aversion behaves. However, an increase in the price of medical care or the coinsurance also raises the price of supplementary insurance, which leads to a negative substitution effect. The latter effect arises because a given out-of-pocket loss occurs at lower levels of illness when medical prices or coinsurance rise. At lower levels of illness, the density of claims increases, so the price of lowering the limit an additional unit is higher when the limit occurs at low illness levels than at higher levels. Although it has been asserted that increased medical prices will increase the demand for insurance (Feldstein, 1973), the theoretical effects are ambiguous.

Finally, increases in both the expected level of illness and in the variance of illness are predicted to increase the demand for supplementary insurance.

To estimate empirically how these factors affect the demand for supplementary insurance, we have fit a probit equation for the dichotomous event of purchasing versus not purchasing supplementary insurance:

$$\text{Probability}(Y_i=1)=\Phi(X_i\beta)$$

$$\text{Probability}(Y_i=0)=1-\Phi(X_i\beta)$$

where Y takes the value 1 if the family indicated it would purchase the hypothetical offer and 0 if not, Φ is the standard normal cumulative density function, the X are characteristics of the family and the offer made to the family, and β are the coefficients to be estimated.[1]

Family characteristics included as explanatory variables are: income, age of the head, education of the head, indicator (0,1) variables for the experimental plans, the family's report of its expected total expenditures in the next year, and family size. Characteristics of the offer include: the percentage reduction in the out-of-pocket maximum and the loading fee implicit in the premium quote. The loading fee was computed based on observed (prior) expenditure distributions for participating families, controlling for family size and experimental plan (see Appendix B).

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[1]An alternative to the probit model is a logit model. For the range of probabilities in these data, probit and logistic regression are very similar. An advantage of the probit is that we can examine intrafamily correlations in the responses given to the alternative offers, as discussed below.

The vector of observations on our dependent variable contains multiple observations for a single family, each observation reflecting the response about a particular hypothetical supplementary offer. The error terms in the equation are therefore likely to be correlated across the responses from a given family because of unmeasured factors that influence its decision. Ignoring this correlation will lead to estimates of inferential statistics that are too large. The coefficient standard errors and statistical tests on the probit equation are corrected for the intrafamily correlation using a technique described by Duan et al. (1982) that avoids the computationally expensive multivariate probit model. The univariate probit model was estimated, treating observations as if they were stochastically independent. The intrafamily correlation in the propensities was estimated using a random subsample of two responses from each family. This estimated correlation was then used to compute an upper-bound adjustment for the standard errors obtained from the univariate probit model.

IV. RESULTS

EFFECTS OF THE PRICE OF INSURANCE

The loading fee was the most significant variable in the probit equation explaining differences in the probability of accepting an offer. For all of the offered reductions in the out-of-pocket maximum, an increase in the loading fee decreases the probability that a family expresses interest in the offer. This result is shown in Table 1, which presents predictions from the probit model of the probability of accepting a hypothetical offer at various loading fees.[1] For each offer and loading fee shown, a prediction is made for each family and then these predictions are averaged over all families in the sample to obtain the results in Table 1.

We also see in Table 1 that at any given loading fee, families express a stronger preference for partial supplementation than for full supplementation, as expected if families are risk averse. Further, increases in the loading fee lead to a greater reduction in the

Table 1

PREDICTED PROBABILITY OF SUPPLEMENTATION, BY LOADING FEE AND OFFERED REDUCTION IN MAXIMUM EXPENDITURE

Loading Fee (%)	Offered Reduction in Maximum Expenditure		
	100%	66%	33%
−30	62%	69%	81%
	(1.7)	(1.4)	(1.4)
−15	55	66	80
	(1.8)	(1.3)	(1.3)
0	47	64	79
	(2.3)	(1.1)	(1.4)
15	40	62	77
	(2.8)	(1.2)	(1.6)
30	34	60	75
	(3.4)	(1.4)	(1.9)

NOTE: Standard error in parentheses.

[1]The full probit equation is given in Appendix C.

probability of choosing full coverage than in the probability of accepting a partial reduction of the out-of-pocket risk.

We have predicted demand at loading fees that range from −0.3 to +0.3 because this spans the range of effective loading fees that exist under current tax policy and could be expected if tax policy is changed. Phelps (1982) estimated that the loading fee charged by insurers averages about +0.17; however, given the subsidy and current tax rates, the effective loading fee faced by the average individual is −0.27.

To obtain a more precise estimate of how demand for first-dollar coverage might change if employer-paid premiums are treated as taxable income, we contrast predicted demand for full supplementary insurance, assuming that premiums are exempt from taxes, with the demand after eliminating the subsidy (Table 2).[2] Our estimates are based on the income distribution in our sample in 1982 dollars and on the personal income and payroll tax structures in 1982. At a nominal loading fee of 0.15, elimination of the tax subsidy reduces the probability of purchasing full supplementary coverage by 19 percentage points. Although the average loading fee currently charged by insurers is approximately 0.15, supplementary insurance would involve many small dollar claims and could be expected to have a higher than average loading fee. Assuming a nominal loading fee of 0.3, elimination of the tax subsidy reduces the probability of purchasing a supplementary policy by over 21 percentage points.[3]

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[2]These estimates are based on 1982 incomes and taxes and were made as follows: Total income was apportioned into wages, property income, and nontaxable income based on Table 740, *Statistical Abstract of the United States, 1981.* Each family's marginal tax rate was computed by adding the estimated wages and property incomes and applying marginal tax rates given in Table 437 of the *Statistical Abstract of the United States, 1982–83.* Marginal tax rates for single person, no dependents in the *Statistical Abstract* were used for families of size 1; the reported marginal tax rates for married couple, 2 dependents were used for all other families. Employer-paid payroll taxes were assumed to be shifted to the employee. The 1982 payroll tax rate was applied if estimated wage income for the family was less than the maximum subject to wages. A zero marginal payroll tax was assumed if wages exceeded the maximum. Thus we understate the effect of eliminating the tax subsidy for two-worker families. Letting t be the personal income plus payroll tax rate, the effective loading fee given the subsidy is $(1+\theta)(1-t)-1$, where θ is the nominal loading fee.

[3]Other recent studies that have looked at the impact of changing the tax subsidy include Phelps (1982) and Taylor and Wilensky (1983). Keeler, Morrow, and Newhouse (1977) estimate maximum loading fees consistent with the purchase of insurance to supplement deductibles ranging from \$50 to \$200; they conclude that little supplementary insurance would be purchased unless the tax subsidy remains.

Table 2

EFFECTS OF CHANGING THE TAX TREATMENT OF EMPLOYER-PAID HEALTH INSURANCE

Nominal Loading Fee (%)	Predicted Probability of Full Supplementation: With Tax Subsidy	Predicted Probability of Full Supplementation: Without Tax Subsidy
15	59%	40%
30	55%	34%

EFFECTS OF CHANGES IN MEDICAL PRICES

The growth of insurance coverage is considered to be a primary cause of the sustained increases in medical prices. More generous insurance coverage encourages increased use of health care services, which puts pressure on medical prices. Some argue that the higher medical prices in turn increase the demand for health insurance leading to a spiraling effect. However, as noted earlier and demonstrated in Appendix D, the effects of increased medical prices on the demand for insurance are theoretically ambiguous. Furthermore, previous empirical work on the effects of changes in medical prices on the demand for insurance have yielded conflicting results (see Phelps, 1976; Feldstein, 1973; and Frech, 1976).

Our results suggest that increases in medical care prices reduce the demand for supplementary insurance; an increase in the experimental coinsurance rate, which is equivalent to an increase in the price of care, reduces the probability that an offer will be accepted. Table 3 compares the predicted probability of purchasing a supplementary policy to reduce a family out-of-pocket maximum by two-thirds for the various coinsurance rates. Predictions are made for the full sample of families enrolled in family maximum plans, assuming that the family is assigned to the plan being predicted rather than just predicting choices for the subsample assigned to the plan.[4] The predictions were then averaged over all families to obtain the reported results. The t-statistics given in Table 3 test the significance of the difference

[4]This is to remove any imbalance in the distribution of family characteristics across plans. Families enrolled in the plan with a fixed individual maximum are not included because there was no variation in the coinsurance rate coupled with the individual maximum plan.

Table 3

PREDICTED DEMAND TO REDUCE BY TWO-THIRDS A FAMILY'S OUT-OF-POCKET LIMIT, AT VARIOUS COINSURANCE RATES

Coinsurance	Predicted Probability (%)	t-test vs. 95% Coinsurance
25%-All services	67	3.1
25%-Medical and 50% mental/dental	65	2.3
50%-All services	56	0.3
95%-All services	55	—

NOTE: Predictions are for those on family maximum expenditure plans and assume a loading fee of 15 percent.

between the 95 percent coinsurance plan and the plans with lower cost sharing.

The predictions come from a specification using indicator (0,1) variables for the plan coinsurance rates, and so a monotonic response has not been imposed. However, the predicted probabilities uniformly fall as the coinsurance rate increases.

EFFECTS OF INCOME

As mentioned earlier, theory suggests that the effects of income changes on the demand for insurance to reduce the maximum out-of-pocket liability may depend on whether the maximum is an absolute dollar amount or a percentage of income. Hence, the specification of the probit model we used interacted income with indicator variables for the three types of maximums—fixed family maximum, fixed individual maximum, and an income-related family maximum.

Table 4 gives the t-statistics on the three income coefficients; these results do not give conclusive evidence about the effects of income on the demand for supplementary insurance. Among families with a fixed family maximum, increases in income decrease the probability of supplementation, which is consistent with decreasing absolute risk aversion in income; however, the coefficient is not significant. On the

Table 4

INCOME EFFECTS ON PROBABILITY OF SUPPLEMENTATION

Type of Maximum	t-Statistic on Income
Fixed family	−0.68
Fixed individual	+3.44
Income-related family	+0.62

other hand, income is significantly positively associated with the demand for supplementation among families with a fixed individual maximum, suggesting that risk aversion increases with income.

When the maximum is specified as a percentage of income, the effect of changes in income on demand reflects not only how risk aversion varies with income, but also the effect of income on the price of supplementation, the latter leading to an increase in demand as income increases. The positive income coefficient for families with an income-related maximum is therefore consistent with increasing, constant, or decreasing risk aversion.

ISSUE OF ADVERSE SELECTION

The amount of adverse selection in health insurance is an important question in structuring competitive approaches to health care financing. To assess the potential importance of adverse selection, we obtained estimates of anticipated health losses by asking the family how much it expected to spend on medical care in the following year. Measures of estimated health expenditures were collected concurrent with the administration of the hypothetical insurance offers.

The importance of anticipated health expenditures in the decision to purchase supplementary insurance is seen in Table 5, where we show predicted probabilities of full supplementation for families in the lowest and highest quartile of the distribution of expected expenditures for their family size.[5] Families with anticipated health expenditures in the highest quartile are significantly more likely to state that they

[5]Predictions are made assuming a 15 percent loading fee, a 95 percent coinsurance rate, and a fixed $1,000 family maximum.

Table 5

PREDICTED PROBABILITY OF FULL SUPPLEMENTATION, BY ANTICIPATED MEDICAL EXPENDITURES

Expenditure	Probability (%)
Lowest expenditure quartile	24
Highest expenditure quartile	34
t-test of difference = 4.4	

NOTE: Predictions are made assuming a 15 percent loading fee, a 95 percent coinsurance rate, and a fixed $1,000 family maximum.

would purchase supplementary insurance than families in the lowest income quartile.

While the predictions shown in Table 5 control for family size, they do not control for other demographic characteristics that may be correlated with both anticipated health expenditures and decisions about supplementary insurance. The predictions reflect the gross effects of anticipated expenditures and all other factors associated with anticipated expenditures. Some of these other factors, such as age, are easily observable and could be used to distinguish risk types. However, after controlling for demographic characteristics, there remains a significant net effect of anticipated expenditures; the t-statistic on this variable in the probit equation was 4.0 and was the most significant family attribute in explaining the purchase decision.

To assess the magnitude of the net effect of expected expenditures, we show point predictions of demand for full supplementation for two families differing only in their anticipated risk, in Table 6. Each family includes four people and has average characteristics. The probability of purchasing the supplementary policy is 5 percentage points higher for the family anticipating $1,750 of expenditures (the upper quartile for the family size) than for the family expecting $650 of expenditures (the lowest quartile).

Differential assessments of risk that cannot be distinguished by insurers on the basis of demographic and economic characteristics do affect the extent of insurance the family would choose to purchase. The existence of equilibria in insurance markets has been questioned (Rothschild and Stiglitz, 1976). Our own results on the effects of adverse selection point toward the potential importance of this issue.

Table 6

NET EFFECTS OF ANTICIPATED EXPENDITURES: PREDICTED PROBABILITY OF FULL SUPPLEMENTATION FOR TWO FAMILIES[a]

Family anticipating expenditures of $650	20%
Family anticipating expenditures of $1750	25%

[a]Each family includes four people and has average characteristics for a family of that size. Each is assumed to be on a 95 percent coinsurance, $1,000 maximum plan, with a loading fee of 0.15.

V. DISCUSSION

At the outset, we noted two features common to many current proposals concerning health care financing: changes in the tax treatment of premiums and an increase in consumer choice among health plans. What are the implications of our results for the current debate about these policies?

Our findings do give evidence that increased consumer choice would lead to adverse selection, and that easily observable characteristics are not sufficient to distinguish risk classes and thereby eliminate the problem. After controlling for demographic and economic characteristics, differential assessments of risk are significantly related to purchase decisions.

Our estimates of the price response of the demand for supplementary insurance indicate that changes in the tax treatment of premiums would have an impact on the extent of insurance purchases. Simulation of the effects of eliminating the tax subsidy suggest that the percentage of families demanding first-dollar coverage would fall by about 20 percentage points if employer-paid premiums were treated as taxable income. Results from the Health Insurance Experiment (Newhouse et al., 1981), showed that cost sharing does have a large, significant impact on the amount of medical care used. Therefore policies that reduce families' demands for full coverage, and increase their preferences for cost sharing in insurance, are likely to reduce the volume of resources we devote to medical care.

On the other hand, we predict a substantially greater demand for supplementary insurance, even absent present tax incentives, than proponents of increased cost sharing anticipate. Feldstein (1971) argues that the provision of catastrophic or major risk insurance would render first-dollar coverage unattractive and the market for such coverage might disappear. Keeler, Morrow, and Newhouse (1977) reach a similar conclusion using a model of insurance choice derived from expected utility theory, assumptions about the degree of risk aversion, and data on the distribution of medical expenses. Further, using a standard economic model of behavior under uncertainty, Arrow (1963, 1973) has shown that the most desirable insurance policy is one that allows a deductible then provides full coverage for expenses above the deductible if the effective loading fee is positive.

If economic theory suggests that first-dollar coverage is not optimal, why then do we predict substantial demand for full supplementation?

Two explanations appear open: (1) Hypothetical data are irrelevant; standard theory has not been refuted by any real behavior. (2) Alternative theories of behavior under uncertainty need to be explored. We briefly consider these explanations

An obvious concern with this study arises from the hypothetical nature of the data. Rather than studying actual insurance purchases, we study instead answers to hypothetical questions posed at the end of the experimental period for our subjects. Are such techniques valid?

As might be expected, marketing survey studies have often pondered just this question: Can hypothetical questionnaires predict actual behavior? In a series of studies, hypothetical questions about major expenditures seemed to predict subsequent behavior well. For example, in a study by Granbois and Summers (1975), questions eliciting intentions to purchase items costing $100 or more, provided *in aggregate* relatively unbiased predictions. Those who stated an expectation of purchasing (say) a refrigerator within the next year of 10 percent actually were observed purchasing refrigerators with about 10 percent probability; those predicting a 20 percent chance purchased about 20 percent of the time, and so forth. This sort of analysis seems to suggest that people can respond to hypothetical questions with relatively little bias. But we have found no data to learn whether the predicted effects (say) of price arising from studies of such data are also unbiased. The literature has concentrated on the accuracy of levels, not derivatives.

However, results from some other recent empirical studies of the demand for supplementary insurance based on observed insurance purchases have produced price elasticity estimates quite consistent with the results of our analyses of hypothetical data. Our estimate of the price elasticity of demand for full supplementary insurance is −0.6, where the price is defined as one plus the effective loading fee or the after-tax payment per unit of expected benefit.[1] In comparison, Holmer (1984), in a study of insurance choices of federal employees, obtained an estimate of the price elasticity of demand for supplementary insurance of −0.5; Long and Settle (1982) estimate the price elasticity of demand for Medicare supplementary insurance to be −0.5 to −0.6.

[1]The elasticity is estimated as:

$$\left(1 + \frac{\text{effective loading}}{\Phi}\right) \varphi(X\beta)\beta_k.$$

where the β are the probit regression coefficients, β_k is the coefficient on the loading fee, and φ and Φ are, respectively, the density and distribution function of the standard normal distribution. The elasticity is evaluated at the mean of all family characteristics and assumes a nominal loading fee of 0.17 and an average marginal tax of 0.38 (Phelps, 1982).

Thus, research on the predictive ability of hypothetical questions and the similarity of our price elasticity estimates with other empirical studies based on observed behavior support the validity of our hypothetical data. The results give credence to the notion that the predicted level of demand for first-dollar coverage based on our hypothetical questions would also be reflected in actual purchase decisions.

Furthermore, a preference for first-dollar coverage has been observed by others. Fuchs (1976) observed that consumers prefer plans that provide first-dollar coverage, even if their catastrophic expenses are not limited, over catastrophic coverage plans with high deductibles. For example, in 1977 over 70 percent of persons covered by group plans had first-dollar coverage for hospital care, but only 49 percent had plans that limited their out-of-pocket expenses for hospital and medical services (Farley and Walden, 1983).

A preference for low deductible plans with limited benefits over plans with higher deductibles but limited benefits is incompatible with expected utility theory, at least under the standard assumption that the utility function of money is concave, or equivalently that consumers are risk averse. This and other disparities between expected utility theory and behavior have led a number of researchers to offer alternative models of choice under uncertainty. For example, prospect theory, as developed by Kahneman and Tversky (1979; and Tversky and Kahneman, 1981), postulates that outcomes are perceived as gains or losses from a reference point, rather than final wealth positions as in expected utility theory; and that the value function in outcomes is concave for gains and convex for losses. Recent elaborations of expected utility theory also permit this behavior when the assumption of independence between utilities and probabilities is dropped (Machina, 1982). Currently, additional analysis of the HIE hypothetical data is under way to examine whether value functions based on prospect theory explain the observed responses better than expected utility theory.

Our empirical findings have bearing on earlier published results showing the magnitude of response to coinsurance based upon the HIE Interim Analysis. Those results (Newhouse et al., 1981) show substantial changes in utilization when coinsurance is imposed. Our results suggest that demand for supplementation could be sufficiently large, even with tax policy changes, to diminish those responses to copayment.[2] Clearly, if people supplement away any copayments, the

[2]This result is in contrast to earlier findings by Keeler, Morrow, and Newhouse (1977).

utilization-reducing effects of cost sharing may be less than predicted. The alternative exists of making a specific plan a "payor of last resort," eliminating most or all incentives to purchase supplementary insurance, and such a device may be needed if cost sharing is to be widely maintained.

However, it must be remembered that the dimensions of adjustment in insurance coverage in our analysis are limited to the magnitude of the catastrophic limit whereas actual choices could change along this dimension, or by altering the scope of benefits, copayments, internal limits of payment, or other aspects of the insurance policy. The consequences for the medical market depend on the ultimate nature of the insurance package. For example, most of the utilization reducing effects of copayments would be retained if supplementary coverage were purchased to provide first-dollar coverage for only hospital care, which historically has been covered with greater prevalence and more completely than other services.[3]

Furthermore, even at effective loading fees that eliminate the tax subsidy, there remains a price distortion (given our assumption about the pricing of supplementary insurance) that may induce oversupplementation. The reduction in cost sharing from the purchase of supplementary insurance leads to additional use of services. The additional use covered by the supplementary plan is taken into account in our computation of the loading fee implicit in the premiums quoted to respondents. However, the base plan pays a share of the costs of the additional use. In calculating loading fees (see Appendix B), we have assumed that the supplementary plan premium does not reflect the additional base plan payout, and that the premium for the base plan is not increased for these who purchase supplementary insurance; the price of supplementary insurance does not include the full additional benefit the beneficiary expects to receive. This, for example, is the situation in the purchase of Medicare supplementary insurance. To remedy this situation, some have proposed that supplemental insurance should be subject to a tax. We are currently examining how the level of demand for supplementary insurance would be affected by such a policy.

Moreover, our computation of loading fees, and hence our estimates of demand at various levels of the loading fee, assume no adverse selection. However, the existence of markets for supplemental insurance depends in part on issues of adverse selection. Our results show that adverse selection may be important; families anticipating high

[3]Newhouse et al. (1981) find that those with full coverage for hospital services and cost sharing for ambulatory services use fewer hospital services as well as fewer ambulatory services than patients with free care.

expenditures are more likely to purchase supplementary insurance than families anticipating low expenditures. Whether or not adverse selection is a problem also depends on how accurately family's anticipations are realized in actual expenditures. Preliminary analysis indicates that anticipations are predictive of subsequent expenditures; controlling for economic and demographic characteristics of the family, the elasticity of actual expenditures with respect to anticipated expenditures is estimated to 0.4 and highly significant. These results call into some question the potential for supplemental insurance markets to sustain themselves. Adverse selection may lead to a premium-adjusting spiral with the result that the market for supplementary insurance disappears. Whether this might happen is a topic now under investigation using simulation techniques. Ironically, "market failure" in the market for supplemental health insurance may be the only way in which another market—that for health care itself—could function in a fashion more closely approximating that portrayed by an economics textbook.

Appendix A

THE HYPOTHETICAL QUESTIONS

The hypothetical question posed to families was as follows:

> SUPPOSE YOU WERE ENROLLED IN A NATIONAL HEALTH INSURANCE PLAN JUST LIKE THE FAMILY HEALTH PROTECTION PLAN, AND YOU HAD THE SAME MAXIMUM DOLLAR EXPENDITURE (MDE), WHICH IS $______ PER YEAR FOR YOUR FAMILY.
>
> (This was the MDE your family had during the most recent year of participation in the FHPP.)
>
> IF YOU COULD LOWER THE MDE TO $______ BY PAYING A FEE OF $______ PER YEAR, WOULD YOU DO IT OR NOT?
>
> _______Yes, I certainly would.
> _______I probably would.
> _______I probably would *not*.
> _______No, I certainly would not.

Three identical questions were posed quoting new MDEs of 0, one-third, and two-thirds of the current MDE.

The analysis treats responses of "Yes, I certainly would" and " I probably would" as indicating an intention to purchase. Similar results were obtained when the dichotomous dependent variable was scored 1 only for those answering "Yes, I certainly would," and 0 for all other responses.

Appendix B

COMPUTATION OF LOADING FEES

This appendix describes the methods used to compute the loading fee implicit in the premiums quoted each family for the purchase of the hypothetical supplementary plan. The premiums quoted for each offer were randomly generated using an algorithm designed to produce premium quotes that ranged from 10 percent of the actual charge in the maximum to almost 100 percent of the charge.

To compute the actuarial value of the full supplementary insurance plan, we used expenditure data from year two in all sites for families enrolled in the experimental plan with zero cost sharing. The data were grouped into five empirical distributions of total expenditures (in 1982 dollars), with different distributions for families of size 1, 2, 3, 4, and 5 or more. A full supplementary insurance plan pays the family's cost-sharing amount under the base plan. For each family responding to the hypothetical questionnaire, the actuarial value of the full supplementary plan was computed by first calculating what the family's cost-sharing amount would be given its base plan for each observation in the expenditure distribution for the appropriate family size and then averaging that amount over all observations in the distribution. To make the actuarial value calculation, the expenditure distribution was adjusted to current dollars for the year in which the family was presented with the hypothetical offer. Given the premium quote for the full supplementary plan and the actuarial value, we then calculate the loading fee implicit in the quote.

By using the expenditure distribution for families enrolled in the zero cost-sharing experimental plan rather than the distribution for the plan the family actually was enrolled in, we have taken into account the additional use induced by the purchase of supplementary insurance. The additional use covered by the supplementary plan is included in the estimated actuarial value of the plan. However, as noted in the text, the base plan also pays a share of the additional use, and we have assumed no change in the base plan premiums for families who purchase supplementary insurance. We are currently studying how the equilibrium share of the supplementary market would be affected if the purchase of supplementary insurance were subject to a tax to account for the additional costs imposed on the base insurance plan.

To compute the actuarial value of the partial supplementary plans, we used the observed expenditure distribution for the plan the family was actually assigned to. We obtained 25 empirical expenditure distributions using data from year two in the four sites, with a different distribution for each family size and plan pair. For each family, we computed their cost-sharing amount under the base plan and the hypothetical offer for each observation in the appropriate expenditure distribution; the actuarial value of the plan is the difference in the average out-of-pocket payments under the two scenarios.

Our method assumes that the purchase of partial supplementary insurance does not induce additional utilization. The partial supplementary plan lowers the family out-of-pocket limit, but below the new limit it still faces a positive coinsurance rate. Analyses of HIE data show that families adjust their spending to the lower price when they reach the out-of-pocket limit, but even for fairly small limits they do not appear to adjust utilization in anticipation of exceeding the limit (Keeler and Rolph, 1982). Therefore, we would expect the purchase of partial supplementary insurance to induce some additional use because the likelihood of exceeding the limit increases when the limit is lowered; however, families purchasing partial supplementary insurance would not be expected to spend at the rate observed for those with free care over the entire expenditure range.

To test the sensitivity of our result to the assumption of no induced demand, however, we also computed loading fees for the partial offers assuming that purchase of supplementary insurance induces families to spend as if they had free care. The results obtained using this alternative assumption were not very different from those reported in the text. At a loading fee of 0, the predicted level of demand under the alternative assumption was 6 percentage points lower than the result in the text for a two-thirds reduction in the limit and 8 percentage points lower for a one-third reduction. An increase in the loading from 0 to 0.15 decreased by 3 percentage points the probability of purchasing a partial plan in contrast to the 2 percentage point decrease given in the text.

The algorithm used to generate premium quotes was intended to vary the loading fee over the range -1 to $+1$. The calculated loading fees had a mean value of -0.13, with a standard deviation of 0.57. Ninety-five percent of the loading fees computed ex post did fall in the target range of -1 to $+1$. The remaining 5 percent were loading fees exceeding 1, however our results were not sensitive to the inclusion of these extreme values.

Appendix C

PROBIT EQUATION FOR PROBABILITY OF SUPPLEMENTATION

Variable	Coeff.	t-statistic
Intercept	1.337	1.46
Loading fee for 1/3 reduction in maximum	−0.333	−3.13
Loading fee for 2/3 reduction in maximum	−0.396	−5.26
Loading fee for full reduction in maximum	−1.266	−8.39
Expected medical expenses next year in 1982 $	0.0002	4.03
Ln (Family Size)	−0.224	−2.78
Plan Indicator (0,1) Variables		
1 if plan with 25% coinsurance	0.340	3.04
1 if plan with 25% coinsurance for medical, 50% coinsurance for dental & medical	0.267	2.23
1 if plan with 50% coinsurance	0.024	0.23
1 if individual deductible plan (fixed individual limit plan)	−1.918	−1.78
1 if fixed family maximum plan	0.357	0.31
Family limit in 1982 $ for individual deductible plan (0 if not individual deductible plan)	−0.0006	−1.38
Maximum as percent of income; 0 if fixed maximum plan	−0.018	−1.16
Amount of fixed family maximum in 1982 $ (0 if not fixed family maximum plan)	0.0002	0.66
Log (Family Income in 1982 $) if income-related maximum plan	0.050	0.62
Log (Family Income in 1982 $) if on fixed family maximum plan	−0.059	−0.68
Log (Family Income in 1982 $) if on fixed individual maximum plan	0.263	3.44
Age of head	−0.023	−1.15
(Age of head)^2	0.0003	1.43
Education (in years) of head	−0.003	−0.33
Site Indicator (0,1) Variables		
1 if Seattle	0.100	1.02
1 if Massachusetts	0.101	1.18
1 if South Carolina	−0.021	−0.20
Offered reduction in maximum	−1.342	−6.62

NOTES: Omitted plan indicator is 95 percent coinsurance; omitted site indicator is Dayton. For families with both a male and female head, age and education of head are measures for the male.

Appendix D

COMPARATIVE STATICS OF THE DEMAND FOR SUPPLEMENTARY INSURANCE

Phelps' (1973) theoretical work on the demand for reimbursement health insurance provides the framework for this study. The consumer is assumed to have a utility function in a composite good, X, and medical care, h. The composite good is the numeraire and the price of medical care is p. The consumer has an insurance policy that specifies a coinsurance rate, c, the fraction of the bill the family pays, and a maximum on out-of-pocket expenditures, cph^* where h^* is the units of care after which the insurance policy pays in full for any additional service use. The premium paid for the policy is R.

Let Θ be the loading fee in the insurance policy, $f(s)$ the distribution of illness losses, and s^* the level of sickness that leads to the purchase of h^* units of care. Then the premium function is[1]

$$R = (1 + \Theta)\left[\int_0^{s^*} (1 - c)phf(s)ds \right.$$

$$\left. + \int_{s^*}^{\infty} [(1 - c)ph^* + p(h - h^*)]f(s)ds \right] .$$

Our hypothetical questions offer consumers the opportunity to purchase supplementary insurance to reduce the amount of their out-of-pocket maximum. For some consumers, the maximum is defined as a fraction, α, of income, that is $cph^* = \alpha I$. A change in α changes the premium by R_α (i.e., $dR/d\alpha$), where

$$R_\alpha = -(1 + \Theta)cp \frac{\partial h^*}{\partial \alpha} \int_{s^*}^{\infty} f(s)ds = -(1 + \Theta)I \int_{s^*}^{\infty} f(s)ds .$$

[1]The amount of medical care, h, purchased depends on the sickness loss; however, for notational convenience we suppress the functional dependence of h on s throughout.

Expressing this in elasticity form, we obtain

$$\frac{\alpha}{R} R_\alpha = -\alpha I \frac{\int_{s^*}^{\infty} f(s)ds}{\text{Actuarial Value of Total Policy}} .$$

The expected benefit gain from a decrease in α is

$$I \int_{s^*}^{\infty} f(s)ds .$$

Thus, the elasticity of R with respect to α is equal to $-\alpha$ times the ratio of the change in expected benefits to the overall expected benefit.

The consumer is assumed to maximize expected utility over all possible illness losses. Expected utility, EU, is given by:

$$EU = \int_0^{s^*} U(X,h)f(s)ds + \int_{s^*}^{\infty} U(X,h)f(s)ds .$$

If $s \leq s^*$, then the budget constraint facing the consumer is given by

$$I = X + cph + R .$$

If $s > s^*$, then the constraint is

$$I = X + cph^* + R .$$

The consumer facing an income-related out-of-pocket maximum of αI can reduce the level of α by purchasing supplementary insurance. Whether he will choose to do so depends on how expected utility changes as α changes where,

$$\frac{\partial EU}{\partial \alpha} = \int_0^{s^*} \left(U_X \frac{\partial X}{\partial h^*} \frac{\partial h^*}{\partial \alpha} + U_h \frac{\partial h}{\partial h^*} \frac{\partial h^*}{\partial \alpha} \right) f(s)ds$$

$$+ \int_{s^*}^{\infty} \left(U_X \frac{\partial X}{\partial h^*} \frac{\partial h^*}{\partial \alpha} + U_h \frac{\partial h}{\partial h^*} \frac{\partial h^*}{\partial \alpha} \right) f(s)ds .$$

Substituting into this expression the first-order conditions for maximizing utility in each sickness state and relationships found by differentiating the budget constraints with respect to α yields

$$\frac{\partial EU}{\partial \alpha} = \int_0^{s^*} - \lambda R_\alpha f(s)ds + \int_{s^*}^{\infty} - \lambda(I + R_\alpha) f(s)ds \quad , \tag{1}$$

where R_α is the marginal premium to supplement and λ is the marginal utility of income.

As we noted earlier, the *expected* rate of change in out-of-pocket payments for a decrease in α is

$$I \int_{s^*}^{\infty} f(s)ds,$$

whereas the realized decrease in out-of-pocket payments is 0 for $s \leq s^*$ and I for $s > s^*$. Letting $\overline{dEXP}(s)$ be the realized change in out-of-pocket expenditures for state s and $\overline{dEXP}$ be the expected change in out-of-pocket expenditures over all states, then Eq. (1) can be written as

$$\frac{\partial EU}{\partial \alpha} = (1 + \Theta)\, \overline{dEXP}\; E(\lambda) + \int_0^{\infty} - \lambda\, \overline{dEXP}(s) f(s)ds$$

$$+ \int_0^{s^*} \lambda\, \overline{dEXP} f(s)ds + \int_{s^*}^{\infty} - \lambda[\, dEXP(s) - \overline{dEXP}\,] f(s)ds$$

$$= \Theta\, \overline{dEXP}\; E(\lambda) - \int_0^{\infty} \lambda[\, dEXP(s) - \overline{dEXP}\,] f(s)ds \quad .$$

The rightmost term in the above expression is the covariance of the marginal utility of income with the change in out-of-pocket expenditure (or risk). Arrow (1976) interprets this as the welfare gain resulting from risk reduction. If we let Π denote the value of this gain measured in money terms, we have

$$\frac{\partial EU}{\partial \alpha} = E(\lambda)(\Theta\, \overline{dEXP} - \Pi) \tag{2}$$

The consumer will accept an offer to lower α if expected utility is increased, that is, if $\partial EU/\partial \alpha < 0$. Therefore, the probability of accepting the supplementary offer is the probability that $\Theta\, \overline{dEXP} < \Pi$; the consumer purchases a supplementary plan if the value of reduced risk is greater than the excess of premium over actuarial value.

For some families in our study, the maximum is not dependent on income, but is a fixed dollar amount $k = cph^*$, and their offer is a reduction in k. A family will choose to purchase the supplementary offer if

$$\frac{\partial EU}{\partial k} = \int_0^{s^*} - \lambda R_k f(s) ds + \int_{s^*}^{\infty} - \lambda (1 + R_k) f(s) ds < 0 \ , \qquad (3)$$

where

$$R_k = \frac{\partial R}{\partial k} = -(1 + \Theta) \int_{s^*}^{\infty} f(s) ds \ .$$

By appropriate definition of $\overline{dEXP}$ and $dEXP(s)$ for the case of a fixed limit, we can obtain a result analogous to Eq. (2). However, the difference between the income-related and fixed-dollar maximum is important when we investigate how exogenous factors affect the decision to supplement.

EFFECTS OF INCOME CHANGES

To determine how the probability of supplementation varies with changes in exogenous variables, we will examine how the optimum out-of-pocket limit varies with the variable of interest. The optimum α for the income-related maximum is found by setting Eq. (1) equal to 0; the optimum k for the fixed-dollar maximum is obtained when Eq. (3) equals 0. To find the change in the optimum α or k as a variable X changes, fully differentiate these first-order conditions to obtain

$$\frac{\partial k}{\partial X} = - \frac{\dfrac{\partial^2 EU}{\partial k \partial X}}{\dfrac{\partial^2 EU}{\partial k^2}} \ ,$$

$$\frac{\partial \alpha}{\partial X} = - \frac{\dfrac{\partial^2 EU}{\partial \alpha \partial X}}{\dfrac{\partial^2 EU}{\partial \alpha^2}} \ .$$

The denominator in each equation is negative if the second-order conditions for a maximum are satisfied. Hence, the sign of $\partial k/\partial X$ is the same as the sign of $\partial^2 EU/\partial k \partial X$ and similarly for $\partial \alpha/\partial X$.

First, we will examine $\partial k/\partial I$ by establishing the sign of $\partial^2 EU/\partial k \partial I$,

$$\frac{\partial^2 EU}{\partial k \partial I} = \int_0^{s^*} - \frac{\partial \lambda}{\partial I} R_k f(s) ds + \int_{s^*}^{\infty} - \frac{\partial \lambda}{\partial I} (1 + R_k) f(s) ds$$

$$+ \int_0^{\infty} - \lambda \frac{\partial R_k}{\partial I} f(s) ds \; .$$

The last term in the above expression equals 0, changes in income do not affect the marginal premium to supplement.[2] Letting r be the Arrow-Pratt risk aversion measure, $r = -((\partial \lambda/\partial I)/\lambda)$, then

$$\frac{\partial^2 EU}{\partial k \partial I} = - \left[\int_0^{s^*} - r \lambda R_k f(s) ds + \int_{s^*}^{\infty} - r \lambda (1 + R_k) f(s) ds \right] .$$

The expression in brackets may be seen to be the first-order conditions for the optimum k weighted by the risk aversion measure. If risk aversion decreases with income (increases as sickness levels rise), then the term in brackets is negative and so the entire expression becomes positive; that is, as income increases the desired level of k increases. If risk aversion is constant in income, then the expression is zero; if risk aversion increases with income, then the expression is negative and the desired level of k falls with income. Thus, we expect increases in income to lead to an increase in the probability of supplementation if risk aversion increases with income and to a decrease in the probability if risk aversion decreases with income.

Now consider the effects of income on the demand for α, the percentage of income at risk.

$$\frac{\partial^2 EU}{\partial \alpha \partial I} = \int_0^{s^*} - \frac{\partial \lambda}{\partial I} R_\alpha f(s) ds + \int_{s^*}^{\infty} - \frac{\partial \lambda}{\partial I} (I + R_\alpha) f(s) ds$$

$$+ \int_0^{s^*} - \lambda \frac{\partial R_\alpha}{\partial I} f(s) ds + \int_{s^*}^{\infty} - \lambda (1 + \frac{\partial R_\alpha}{\partial I}) f(s) ds$$

[2]We assume that $f(s)$ is independent of income.

$$+ \lambda(s^*)f(s^*)I \frac{\partial s^*}{\partial h^*} \frac{\partial h^*}{\partial I} .$$

Since

$$\frac{\partial R_\alpha}{\partial I} = -(1+\Theta)\int_{s^*}^{\infty} f(s)ds + (1+\Theta)If(s^*) \frac{\partial s^*}{\partial h^*} \frac{\partial h^*}{\partial I}$$

$$= -(1+\Theta)Q^* + (1+\Theta)If(s^*) \frac{\partial s^*}{\partial h^*} \frac{\partial h^*}{\partial I} ,$$

we have,

$$\frac{\partial^2 EU}{\partial\alpha\partial I} = \left[-\int_0^{s^*} - r\lambda R_\alpha f(s)ds + \int_{s^*}^{\infty} - r\lambda(I + R_\alpha)f(s)ds \right]$$

$$+ \left\{ \int_0^{s^*} \lambda(1+\Theta)Q^* f(s)ds + \int_{s^*}^{\infty} \lambda[-1 + (1+\Theta)Q^*]f(s)ds \right\}$$

$$- E(\lambda)(1+\Theta)f(s^*) \frac{\partial s^*}{\partial h^*} h^* + \lambda(s^*)f(s^*) \frac{\partial s^*}{\partial h^*} h^* .$$

The first two terms in brackets are the pure income effect on the demand for the amount of insurance dependent on how risk aversion varies with income. This is analogous to the income effect in the previous case of a fixed maximum. The middle two terms in braces are zero by the first-order conditions (multiply and divide by I and note that $(1 + \Theta)Q^*I = -R_\alpha$). The remaining terms arise because a change in income decreases the level of coverage for a given α. This effect is negative, and, given a desired dollar limit, a change in income will lead to demand for a lower α. Put differently, the "real price" of insurance, which is $R_\alpha/-(I + R_\alpha)$ following the Ehrlich and Becker (1972) formulation, falls as income rises and there is a substitution effect on the demand for α. However, with a fixed out-of-pocket maximum, the real price of insurance is unchanged by an income change,

and so only income effects were obtained. Thus, observing a positive relationship between income and the probability of purchasing supplementary coverage to reduce α is consistent with increasing, constant, or decreasing risk aversion. The income effect is not sufficient to infer how risk varies with income; a positive income effect is consistent with increasing, constant, or decreasing risk aversion.

EFFECTS OF CHANGES IN THE LOADING FEE

The effects of a change in the loading fee on the demand for a fixed maximum are similar to the effects on demand for an income-related maximum, so we will examine how k changes with Θ by signing $(\partial^2 EU/\partial k \partial\Theta)$.

$$\frac{\partial^2 EU}{\partial k \partial \Theta} = \int_0^{s^*} \left(-\lambda \frac{\partial R_k}{\partial \Theta} - R_k \frac{\partial \lambda}{\partial \Theta} \right) f(s) ds$$

$$+ \int_{s^*}^{\infty} \left[-\frac{\lambda \partial R_k}{\partial \Theta} - \frac{\partial \lambda}{\partial \Theta} (1 + R_k) f(s) ds \right] .$$

Since $\partial\lambda/\partial\Theta = -R_\Theta(\partial\lambda/\partial I)$ (see Phelps, 1973) and $(\partial R_k/\partial\Theta) = -Q^*$,

$$\frac{\partial^2 EU}{\partial k \partial \Theta} = Q^* E(\lambda) + R_\Theta \left[\int_0^{s^*} - r\lambda R_k f(s) ds + \int_{s^*}^{\infty} - r\lambda(1 + R_k) f(s) ds \right] .$$

The first term is the substitution effect; at higher loading fees, one will demand a higher limit, that is, less insurance. The remainder of the expression is the pure income effect, which depends on how risk aversion varies with income.

Observe that the effect of a change in the loading fee on the demand for supplementary insurance is similar to a change in the own price of any good: It consists of a negative substitution effect and an income effect that will also result in a decrease in demand as the loading fee rises as long as insurance is a "normal good." However, as in the standard problem, if insurance is an inferior good it is possible that the positive income effect will dominate the substitution effect and demand will increase as the loading fee increases.

EFFECTS OF CHANGES IN MEDICAL PRICES AND THE COINSURANCE RATE

The effects of changes in the coinsurance rate or medical prices on the desired maximum out-of-pocket limit are qualitatively similar in our case because the coinsurance rate is exogenous. Let us examine $\partial k/\partial c$ by signing $\partial^2 EU/\partial k \partial c$.

$$\frac{\partial^2 EU}{\partial k \partial c} = \int_0^{s^*} - \frac{\partial \lambda}{\partial c} R_k f(s)ds + \int_0^{s^*} - \lambda \frac{\partial R_k}{\partial c} f(s)ds$$

$$+ \int_{s^*}^{\infty} - \frac{\partial \lambda}{\partial c}(1 + R_k) f(s)ds$$

$$+ \int_{s^*}^{\infty} - \lambda \frac{\partial R_k}{\partial c} f(s)ds + \lambda(s^*) f(s^*) \frac{\partial s^*}{\partial h^*} \frac{\partial h^*}{\partial c}$$

substituting in expressions for $\partial \lambda/\partial c$ and

$$\frac{\partial R_k}{\partial c} = (1 + \Theta) f(s^*) \frac{\partial s^*}{\partial h} \frac{\partial h^*}{\partial c} \quad :$$

$$\frac{\partial^2 EU}{\partial k \partial c} = \left[\int_0^{s^*} - \lambda r R_k (R_c + ph) f(s)ds \right.$$

$$\left. + \int_{s^*}^{\infty} - \lambda r (1 + R_k)(R_c + ph^*) f(s)ds \right]$$

$$+ \int_0^{s^*} R_k \left(p\lambda \frac{\partial h}{\partial I} \right) f(s)ds + \lambda(s^*) f(s^*) \frac{\partial s^*}{\partial h^*} \frac{\partial h^*}{\partial c^*}$$

$$- E(\lambda)(1 + \Theta) f(s^*) \frac{\partial s^*}{\partial h^*} \frac{\partial h^*}{\partial c} \; .$$

The expression in brackets is a weighting of the first-order conditions by the risk aversion measure and the factors $(R_c + ph)$ and $(R_c + ph^*)$. These latter factors increase with sickness levels up to s^*; therefore, if risk aversion decreases, is constant, or increases sufficiently little in income (implying risk aversion increases, is constant, or decreases sufficiently little as sickness levels increase), then the expression in brackets is negative. The third term is also negative (if $\partial h/\partial I$ is positive). Hence, income effects lead to demand for a lower out-of-pocket limit as coinsurance increases.

However, increases in coinsurance change the "real price" of insurance. The "real price" of supplementary insurance is $R_k/-(1 + R_k)$, in the Ehrlich and Becker sense, which increases as coinsurance increases and hence tends to reduce the demand for supplementation. At higher coinsurance rates, the price of lowering the out-of-pocket maximum increases because the higher the coinsurance rate, the greater the density of claims at the limit. The increase in the price of supplementation as the coinsurance rate increases tends to increase the desired level of the limit (reduce the demand for supplementation). This is reflected in the last term that is positive ($\partial h^*/\partial c$ is negative). Hence, the net effects of changes in coinsurance or medical price on the demand for supplementation are ambiguous.

Although the net effects cannot be signed in general, we do observe that increases in coinsurance or medical prices will lead to an increased demand for supplementation if the out-of-pocket limit in the base policy is sufficiently high *and* the loading fee is sufficiently small. The last two terms in the expression, and hence the entire expression, is negative if $\lambda(s^*)$ is greater in value than $E(\lambda)(1 + \Theta)$. This occurs if s^* is large and Θ is small.

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