Economic Research Initiative on the Uninsured
CONFERENCE DRAFT

WORKER SORTING, HEALTH INSURANCE COVERAGE & WAGES

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July, 2004

Acknowledgment: We thank the Robert Woods Johnson Foundation for funding through the Economic Research Initiative on the Uninsured. We are grateful to Peter Diamond and Jon Gruber for helpful conversations and to Didem Bernard for advice regarding data. We are solely responsible for the views expressed in this paper and for any errors of fact or interpretation.

Abstract

When firms set wages and health insurance benefits, they must offer the same insurance benefits to all workers. We develop an equilibrium model in which some firms offer health insurance for free, some require an employee contribution to the premium and some do not offer insurance. Making the employee contribution pre-tax lowers the cost of the premium and encourages more firms to charge. This increases the offer rate and lowers the take-up rate with an indeterminate effect on coverage. A calibration exercise suggests that between 1987 and 1996 lowering the effective tax rate significantly lowered coverage.

Introduction

Since roughly 1980, there has been a dramatic decline in the fraction of workers who are covered by employer-provided health insurance (Farber and Levy, 2000;) and a similarly dramatic increase in the proportion of those obtaining health insurance through their employer who contribute to the cost of the premium (Gruber and McKnight, 2002). During the same period, the use of section 125 plans, which allow employee contributions to insurance premiums to be paid on a pre-tax basis has grown slowly with the expansion accelerating in the 1990's (Dranove, Baker and Spier, 2000; Gruber and McKnight, 2002). Also over this period, the number of workers in firms providing health insurance has grown while the take-up rate has declined (Farber and Levy, 2000).

This paper suggests that these facts are related: the decline in the tax wedge increases the fraction of employers providing health insurance but also increases the proportion requiring an employee contribution and the amount of the required contribution. These shifts alter both the proportion of workers with employer-provided insurance and the composition of the group obtaining insurance through their employer and the wages received by different classes of worker.

To understand the existence of employee premium payments, we must recognize that firms have only a limited ability to discriminate among workers with respect to the plans that they offer and that sorting of workers across firms is imperfect (Pauly, 1986). Otherwise, firms would tailor policies to individual workers or would have a homogeneous set of workers desiring the same policy. Levy (1998), Dranove, Baker and Spier, Gruber and McKnight and (implicitly) Bernard and Selden (2002) examine the consequence of imperfect sorting for firms' decisions regarding insurance provision. However, they do not endogenize the mismatching.[1]

[1] Dey and Flinn (2002) is closest in spirit to this paper in that it describes equilibrium behavior. However, their model cannot be used to examine employee contributions. Moreover, their assumptions ensure that the provision of health insurance is always efficient conditional on where the worker is employed. The mismatching is a result of labor market imperfections not of imperfections directly related to the insurance problem.

In our model, mismatching arises because firms are compelled to offer health insurance in a nondiscriminatory fashion. Production requires two different types of workers (low and high skill) with different distributions of willingness to pay for health insurance. Some high skill workers with high valuations of health insurance must be matched with low skill workers with low valuations. Despite the tax advantages to offering health insurance for free, if the low skill workers' valuations are sufficiently low, it is efficient (and profitable) for the firm to charge for health insurance.

In equilibrium, some firms choose to offer health insurance for free to all employees; others offer health insurance but require an employee contribution while yet others do not offer health insurance at all. When firms require a contribution, some, but not all, workers choose to purchase health insurance. Workers who must pay part of the premium receive a compensating differential for this cost, as do workers without health insurance. Thus workers implicitly pay for the health insurance that they nominally receive for free, as is standard in models of compensating differentials.

Because there is a distortionary tax wedge, some workers who value health insurance at more than its cost do not get insurance. Others who value it at less than its cost nevertheless receive free health insurance from their employer. Yet reducing the tax wedge is not unambiguously good. It has an ambiguous effect on the proportion of workers receiving health insurance through their employer. The proportion of workers receiving health insurance for free declines while the proportion of workers in firms offering health insurance rises and the take-up rate declines. If our objective is to increase the prevalence of health insurance, reducing the tax wedge may be harmful. Moreover, the tax wedge affects wages. Reducing the wedge can lower the wages of the less skilled workers.

To get a sense of the magnitudes of these effects, we extend the model to allow for the existence of two insurance plans (good and bad) and calibrate the model for 1987 and 1996. Our estimates imply that the tax wedge declined from 42% to 33% over that period. This decline in the tax wedge more than accounts for the rise in the offer rate and decline in the take-up rate. The results also suggest that the wedge generates considerable inefficiency but that there are significant redistributional effects of eliminating the wedge so that some workers gain from the wedge despite this inefficiency.

We also briefly examine two further extensions: making willingness to pay endogenous to earnings and allowing for more than two types of workers. We show, through a series of numerical examples, that the principal results of the basic model continue to hold.

1 The Intuitive Argument

Suppose that there is only one type of health insurance and that it costs firms p per insured worker to provide the insurance. Firms offer workers a wage and may also offer the opportunity to purchase insurance at a cost, c, chosen by the firm. The cost to the worker of purchasing the insurance is γc where $\gamma > 1$ because, for example, the worker pays for the insurance in after-tax dollars. A payment of γc might reduce the firm's cost by only c because of adverse selection. We expect that the results would be similar but do not formally model adverse selection.

For purposes of simplifying the intuition, suppose that each firms requires exactly one skilled and one unskilled worker. There are equal numbers of the two types. More skilled than unskilled workers value health insurance at more than its cost to firms. By the usual arguments, the economy will organize itself so that it is constrained efficient. Skilled and unskilled workers who value health insurance at more than its cost will be matched and will receive health insurance for free. Skilled and unskilled workers who value health insurance at less than its cost will also be matched and will work in firms that do not offer health insurance but offer a higher wage to compensate workers for the absence of insurance. Because the distribution of willingness to pay differs between the two groups, there will be some left over skilled workers who are willing to pay this cost and some left over unskilled workers unwilling to pay the cost. These workers must still be matched.

How does the market resolve this inefficient matching? There are three options. It can give them both insurance for free, deny them both insurance or require an employee contribution for insurance in such a way that the skilled worker who places a high value on insurance purchases it while the unskilled worker who places a low value on insurance does not. Each of these solutions involves an inefficiency. In the first case, a worker who values insurance at less than its cost receives it nevertheless. This cost is small when the unskilled worker values the insurance almost at its cost and will be the market solution in that case. In the second case, a worker who values insurance at more than its cost is unable to obtain insurance. If the worker values insurance at only slightly more than its cost, this inefficiency is small, and the efficient solution is to deny the worker insurance. In the third case, the inefficiency arises because the insurance costs the worker more than the firm receives from the worker. If the skilled worker values the insurance at significantly more than its cost and the unskilled worker values it at significantly less than its cost, this is nevertheless the most efficient solution.

Thus there are three types of firms in equilibrium: those that offer health insurance for free to all workers, those that offer insurance but require an employee premium and those that do not offer health insurance. Those skilled workers who place the highest value on insurance are in the first two types and purchase the insurance. Those unskilled workers who place the highest value on it are only in firms offering insurance for free. Unskilled workers do not purchase the insurance in the firms that require an employee premium payment. The existence of these intermediate firms depends on γ not being too large and the distribution of willingness to pay being sufficiently different.

In this setting, will eliminating the tax wedge increase or decrease coverage? To see that the effect is unsigned, consider an extreme case where all skilled workers value insurance at more than its cost to employers and all unskilled workers value it at less than its cost. In the absence of a tax wedge, firms can set the employee share of the premium at 100%. In this case, all skilled workers and no unskilled workers purchase the insurance. The offer rate is 100%, and the take-up and coverage rates are 50%.

Suppose now that the tax wedge is very high. If all skilled workers valued insurance at considerably more than its employer costs and all unskilled workers valued it at almost its employer cost, employers would offer health insurance to all workers for free. The coverage rate would be 100%. Eliminating the tax wedge would reduce coverage.

At the other extreme, if all skilled workers valued the insurance at only slightly above its employer cost and all unskilled workers put a positive value on health insurance but considerably less than employer cost, in equilibrium firms would not provide insurance, and the coverage rate would be 0%. In this case, eliminating the tax wedge would increase coverage.

More generally, as we have seen, there will be three types of firms. The offer rate will be positive but less than 100%, the take-up rate will be less than 100% and the coverage rate could be greater or less than 50% even when the taste distributions are so different. Thus the simple example suggests that reducing the tax wedge increase the offer rate, reduces the take-up rate and has an ambiguous effect on the coverage rate. We prove this more rigorously in the next section.

2 The Basic Model

There are N types of workers $1, 2, 3, ...N$ distinguished by the type of work they do, each with measure m_i. Worker type is exogenous. Within each type, there is a distribution $F_i(b)$ of willingness to pay for health insurance with $0 < F_i(p) < 1$ where p is the cost to employers of providing health insurance to an employee. F_i is continuous, with no mass points and with $F_i' > 0$ everywhere in the support.

Further assume that

$$F_1(b) \leq F_2(b) \leq ... \leq F_N(b),$$

with strict inequality for all i, $0 < F_i(b) < 1$. While we treat willingness to pay as exogenous, implicitly we think of type 1's as having greater willingness to pay because their earnings are higher.[2] We present an example later in which willingness to pay depends on earnings. Worker type is exogenous.

Output is produced according to a production function that is homogeneous of degree one, that is

$$q(L_1, L_2, ...L_N) = L_N q(\frac{L_1}{L_N}, \frac{L_2}{L_N}, ..., \frac{L_{N-1}}{L_N}, 1) \equiv L_N q(\frac{L_1}{L_N}, \frac{L_2}{L_N}, ..., \frac{L_{N-1}}{L_N}).$$

There is a single type of health insurance. This assumption is relaxed in a later section.

Firms pay p for each worker for whom they provide health insurance. They may require that employees who accept health insurance pay part of the premium. If so, the amount received by the firm is c. The cost to the worker is γc, $\gamma > 1$. We model γ as arising from differential tax treatment of firm and worker health insurance premiums. Note that setting $c > \bar{b}/\gamma$ where $\bar{b}$ is the highest willingness to pay is equivalent to not offering health insurance.

Firms choose the wage they offer each type of worker (w_1, $w_2, ...w_N$), the health insurance payment, c, required of each worker who takes health insurance and the number of workers of each type that they hire (L_1, L_2, ..., L_N). They may not condition the wage on the worker's decision whether or not to purchase health insurance through the firm and may not condition the employee-paid premium on worker type.

Thus the firm maximizes profit given by

$$\pi = q(L_1, L_2, ...L_N) - \sum_{j=1}^{N} \sum_{i \in L_j} (w_j + [p - c]H_i)$$

where H_i equals 1 if the worker takes health insurance and 0 otherwise.

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[2] Starr-McCluer (1996) finds a strong positive relation between wealth and insurance. It is plausible that workers with lower earnings and wealth are more likely to be eligible for government-provided healthcare in the event of a catastrophic illness and therefore place a lower valuation on insurance.

Each worker chooses the firm that maximizes his utility which is given by

$$u_i = w_i + (b_i - \gamma c)H_i.$$

2.1 Equilibrium

Definition 1 *An equilibrium is a (2N+1)-tuple for each firm* $\{w_1, w_2, ..., w_N, c, L_1, L_2, ..., L_N\}$ *s.t. no firm can increase its profit by choosing different values of* $\{w_1, w_2, ..., w_N, c, L_1, L_2, ..., L_N\}$*; all firms make zero profit; all workers are employed, and no worker can increase his utility by switching to a different firm.*

Note that because production is constant returns to scale, the size of individual firms is indeterminate.

The proof of the equilibrium, which is relegated to the appendix, proceeds as follows. We show first that all workers of a given type at a firm either purchase or do not purchase insurance and that if all workers take insurance the firm must provide it for free. It follows immediately that all firms fall into one of no more than 2^N types summarized by the set of types receiving insurance at that firm. We then show that the set of types receiving health insurance at a firm must be a proper subset of the the sets receiving insurance at firms where more types are receiving insurance. Thus in the case of three types, there are, at most, four types of firms. However, without strong restrictions on tastes and technology, we are not able to reduce the set of potential equilibria to one. Therefore in the remainder of the section, we limit ourselves to the case of two types, relegating the three worker case to an example in a later section. The two types of workers 1 and 2 are distinguished by the type of work they do. It may be helpful to think of these as high and low skill workers or as white-collar and blue-collar workers.

Proposition 1 *In equilibrium, there are at most three offers: some firms offer* $(w_1^A, w_2^A, 0)$*, others offer* (w_1^B, w_2^B, c^*)*, and yet others offer* (w_1^C, w_2^C, ∞)*. If all three* *offers are present in equilibrium,*

$$w_1^B = w_1^A + \gamma c \quad (1)$$

$$w_2^B = w_2^A + \gamma c \quad (2)$$

$$w_2^C = w_2^B \quad (3)$$

$$w_1^C = w_1^A + p + (\gamma - 1)c \quad (4)$$

$$b_1^* = p + (\gamma - 1)c \quad (5)$$

$$b_2^* = \gamma c \quad (6)$$

where b_i^* represents the individual of type i with the highest valuation of health insurance among those not obtaining insurance.

Proof. see appendix ■

Equation (1) reflects the compensating differential that type 1 workers require in order to be indifferent between getting insurance for free and paying c. Since charging for insurance is costly, c is set so it is just sufficient to deter a type 2 worker from accepting the job and purchasing insurance. Therefore the highest willingness to pay of any type 2 worker in a B or C firm must be γc which is also the compensating differential this worker requires to be indifferent between A firms and B and C firms, which gives (2) and (6). Workers who do not get health insurance do not care whether it is offered and how much the firm charges for it which explains (3). Since $w_2^B = w_2^C$, the cost of employing type 1 workers must be the same at B and C firms which gives (4), and this wage differential must leave the marginal type 1 worker indifferent between employment in an A or B firm or in a C firm which gives (5).

If the distribution of willingness to pay for health insurance is sufficiently similar for the two groups and if the inefficiency associated with charging for health insurance is sufficiently high (γ is sufficiently greater than 1), the equilibrium reduces to one in which each firm either offers health insurance for free or does not offer it. We find this case uninteresting and for the remainder of the paper restrict ourselves to the case where all three offers exist in equilibrium.

We now have all of the elements to fully characterize the equilibrium. This is summarized in the proposition below:

Proposition 2 *In equilibrium*

$$q(\theta_A) - (w_1 + p)\theta_A - (w_2 + p) = 0 \tag{7}$$

$$q(\theta_B) - (w_1 + p + (\gamma - 1)c)\theta_B - w_2 - \gamma c = 0 \tag{8}$$

$$q(\theta_C) - (w_1 + b_1^*)\theta_C - w_2 - \gamma c = 0 \tag{9}$$

$$L_C\theta_c/m_1 = F_1(b_1^*) \tag{10}$$

$$L_A/m_2 = 1 - F_2(\gamma c) \tag{11}$$

$$q'_A = (w_1 + p) \tag{12}$$

$$q'_B = (w_1 + p + (\gamma - 1)c) \tag{13}$$

$$q'_C = (w_1 + b_1^*) \tag{14}$$

Proof. see appendix. ■

Equations (7)-(9) are the zero-profit conditions. Equations (10) and (11) require that the number of workers in each type of firm conform to the number with the appropriateness willingness to pay. Equations (12)-(14) are the usual first-order conditions. Note that there is only one per type of firm because of the constant returns to scale assumption.

Note that from Proposition 1 $b_1^* = p+(\gamma-1)c$ and therefore $q'_B = q'_C$ and $\theta_B = \theta_C$.

While our main focus in this paper is on the comparative statics of the model, it is worth noting that the model has interesting implications for compensating differentials which we hope to explore in future work:

1. The compensating differential for being in a firm that charges for health insurance exceeds the charge.

2. Workers receive the same compensating differential for being in a firm that charges for health insurance regardless of whether they actually purchase the health insurance.

3. Workers receive the same compensating differential for not receiving health insurance regardless of whether the firm offers it.

4. The compensating differential for not having health insurance is larger in the group with the higher demand for health insurance.

3 The Effect of Changing the Tax Wedge

In this section we examine the effect of changing the tax wedge on wages in each type of job, the employee premium for health insurance in firms that require an employee contribution and the proportion of each type of worker employed in each of the three types of firms. Proofs of all propositions in this section are relegated to the appendix.

Our first result is quite intuitive. Increasing the tax wedge, increases the inefficiency associated with having employees contribute to the cost of their health insurance premiums. As a consequence, the employee contribution falls in type B firms. This is stated formally in the following proposition.

Proposition 3 $\frac{dc}{d\gamma} < 0$.

How beneficial to workers is this decrease in the employee contribution? On the one hand, when the tax wedge goes up, the employee contribution goes down. On the other hand, the cost of any fixed contribution goes up. Which effect dominates? The next proposition establishes that the total cost of employee contribution ($c\gamma$) goes down as γ goes up.

Proposition 4 $d(c\gamma)/d\gamma < 0$.

Since we have already established that $c\gamma$ is equal to the cutoff willingness to pay for health insurance (b_2) below which type 2 workers do not get health insurance, we have the following corollary:

Corollary 1 *Increasing the tax wedge raises the fraction of type 2 workers getting health insurance.*

And since $c\gamma$ is also equal to the compensating differential received by type 2 workers, we have

Corollary 2 *Increasing the tax wedge lowers the compensating differential received by type 2 workers who do not get health insurance.*

To find how the tax wedge affects the number of type 1 workers getting health insurance, we must look at how it affects the compensating differential received by type 1 workers who do not get health insurance. The following theorem establishes that when the tax wedge goes up, the compensating differential between type 1 workers receiving health insurance for free and those not receiving health insurance goes up.

Proposition 5 $d(p + (\gamma - 1)c)/d\gamma > 0$

Corollary 3 *Increasing the tax wedge lowers the fraction of type 1 workers getting health insurance.*

We have established that when the tax wedge goes up, there are fewer type 2 workers without health insurance and thus more in type A firms and that there are fewer type 1 workers with health insurance and thus more in type C firms. It is therefore not too surprising to find that there are fewer of both types of worker in type B firms when the tax wedge increases. We state this formally in the next theorem.

Proposition 6 $dL_B/d\gamma < 0$, $d(\theta_B L_B)/d\gamma < 0$.

When the tax wedge increases, the number of type B workers with health insurance increases while the number of type A workers with health insurance falls. What then is the overall effect of an increase in the tax wedge on health insurance coverage? Given that the two effects work in opposite directions, it is perhaps not surprising that the effect is unsigned. An increase in the tax wedge, lowers the number of workers with health insurance if, in a sense made precise in the proposition below, at the margin between receiving and not receiving health insurance, the density of type 1 workers is sufficiently large relative to the density of type 2 workers.

Proposition 7 *The proportion of workers with health insurance coverage falls when the tax wedge rises if and only if*

(15)

$$m_1 f_1[(L_B + L_C)q_A'' + q_B''(L_A - m_2 f_2 q_A''(\theta_A - \theta_B)^2)] < m_2 f_2[(L_B + L_C)q_A''\theta_A + L_A q_B''\theta_B].$$

A sufficient condition for (15) is that $m_1 f_1/m_2 f_2 > \theta_A$ where f_1 is the density of type 1 workers evaluated at b_1 and f_2 is the density of type 2 workers evaluated at b_2. Since θ_A must be greater than m_1/m_2, this condition will frequently be violated so that there is no reason to expect that reducing the tax wedge will increase coverage.

We have seen that, when the tax wedge increases, the wages of type 1 workers in type C firms increase relative to those in type A firms and that the wages of type 2 workers in B and C firms fall relative to those in type A firms. What happens to the relative wages of type 1 and type 2 workers? Our intuition suggests that increasing γ makes providing health insurance more expensive and should reduce demand for the group that most values it. However, our intuition is incorrect. The following proposition provides an uninformative condition under which the wages of type 1 workers in type A firms rise and wages of type 2 workers in these firms fall.

Proposition 8 $dw_1/d\gamma < 0$ *and* $dw_2/d\gamma > 0$ *if and only if*

$$L_B + L_C + m_2 f_2 q_B''(\theta_A - \theta_B)\theta_B > 0. \quad (16)$$

Recall that the compensating differential for being in a type B firm is the same for the two types of workers and that the compensating differential for being in a type C firm rises for type 1 workers and fall for type 2 workers when γ rises. Therefore (16) is a necessary and sufficient condition for the wages of all type 1 workers to rise relative to type 2 workers in the same firm.

We can, however, draw a more definitive conclusion about wages in firms where type 1 workers do not receive health insurance. As summarized in the proposition below, in such firms, the wages of type 1 workers rise which, in turn, implies that the wages of type 2 workers without health insurance go down when the tax wedge increases.

Proposition 9 $dw_1^C/d\gamma > 0$ $dw_2^C/d\gamma < 0$.

As discussed in the introduction, over the last twenty-five years, the expansion of section 125 plans has effectively reduced the tax wedge between employer and employee payments for health insurance premiums. The results in this section reveal that this reduction should have increased the number of workers being offered health insurance, increased the number for whom insurance is available but for which they must make a contribution to the premium, reduced the number who receive health insurance for free and had an ambiguous effect on the number of workers receiving health insurance through their employer. The reduction in the tax wedge should also have had effects on the wage structure. While the effect on the wages of workers with free health insurance is ambiguous, the compensating differential for not having health insurance should have increased for groups in which health insurance is relatively uncommon and decreased in groups in which it is relatively common. The decline in this compensating differential should have been sufficient to lower wages among workers without health insurance in the high prevalence group.

We hope to examine the wage implications empirically in future work. In this paper, we focus on the implications for the prevalence of employer-provided health insurance. To do this, we must extend the model.

4 Multiple Plans

In this section, we expand the model to allow for the existence of multiple plans. We examine the case with one good (more generous) and one bad (less generous) plan and focus on equilibria in which some firms offer both plans. We begin by deriving the equilibrium. We then choose parameters to match the model to data for 1987 and 1996 and use the calibrated model to examine the importance of changes in the tax wedge for explaining changes in the availability of insurance and in the take-up rate.

4.1 The equilibrium

We assume there are two medical insurance plans (good and bad). The cost of the plans is given by $p_G > p_B$. As before, there are two types of workers 1 and 2, distinguished by the type of work they do, each with measure m_i. We now use b to denote willingness to pay for the *bad* health insurance. As in the section with only one type of insurance, willingness to pay among group i is given by $F_i(b)$, $0 < F_i(p_B) < 1$ and

$$F_1(b) \leq F_2(b),$$

with strict inequality everywhere $0 < F_i(b) < 1$. Workers' willingness to pay for the good health insurance is vb, $v > 1$ and $0 < F_i(\frac{p_G}{v}) < 1$. We assume that F is continuous with no mass points.

Firms choose the wage they offer each type of worker (w_1, w_2), the health insurance payment c_G, c_B required of each worker who takes health insurance and the number of workers of each type that they hire (L_1, L_2). As before, they may not condition the wage on the worker's decision whether or not to purchase health insurance through the firm or the type of insurance purchased and may not condition the employee-paid premium on worker type.

Definition 2 *An equilibrium is a six-tuple* $\{w_1, w_2, L_1, L_2, c_G, c_B\}$*for each firm s.t.*

no firm can increase its profit by choosing different values of $\{w_1, w_2, L_1, L_2, c_G, c_B\}$; *all firms make zero profit; all workers are employed, and no worker can increase his utility by switching to a different firm.*

We show in the appendix that there are two possible sets of equilibria. The first consists of five offers of the form GG, GO, BB, BO, OO and some subsets of these offers. These equilibria do not appear to offer any additional insights beyond those obtained with the single health insurance plan since no firm offers two plans. The second set of equilibria consists of GG, GB, GO, BB, OB, OO and some subsets of these offers. We can show that the full six-offer equilibrium does not exist if the ratio of the price of the good plan to the price of the bad plan (p_G/p_B) is greater than 2 and for realistic values of γ generally must be greater than 3.[3] Since we will not use a price ratio of this magnitude and since our experience suggests that the actual bound is tighter than the theoretical bound we have found, we will work with a five-offer variant of this equilibrium. The equilibrium of the form GG, GB, BB, OB, OO is ruled out by the restrictions on the distribution of tastes while GG, GO, BB, OB, OO does not have any firms offering multiple plans. Thus we focus on the equilibrium with five offers of the form GG, GB, GO, BB, OO.

4.1.1 The GG, GB, GO, BB, OO Equilibrium

The compensation costs associated with each offer are given in the table below. Details of the derivation are given in the appendix.

COMPENSATION COSTS		
Firm Type	Type 1 Worker Cost	Type 2 Worker Cost
GG	$w_1 + p_G$	$w_2 + p_G$
GB	$w_1 + p_G + \frac{\gamma-1}{\gamma}(v-1)b_2^G$	$w_2 + p_B + (v-1)b_2^G$
BB	$w_1 + p_B + (v-1)b_1^G$	$w_2 + p_B + (v-1)b_2^G$
GO	$w_1 + p_G + \frac{\gamma-1}{\gamma}vb_2^B$	$w_2 + b_2^B + (v-1)b_2^G$
OO	$w_1 + b_1^B + (v-1)b_1^G$	$w_2 + b_2^B + (v-1)b_2^G$

[3] Details available from the authors on request.

We rely primarily on numerical results for this equilibrium since there are relatively few analytic results. However, we can show that the existence of the tax wedge leads to inefficiency. To see this, let q_i^j denote the compensation cost for type i workers in firms of type j. Note that since $q_2^{GB} = q_2^{BB}$,

$$q_1^{BB} = q_1^{GB} > q_1^{GG} \tag{17}$$

which implies that

$$(v-1)b_1^G > p_G - p_B. \tag{18}$$

Similarly $q_2^{GB} < q_2^{GG}$ and therefore

$$(v-1)b_2^G < p_G - p_B. \tag{19}$$

Too few type 1's and too many type 2's get the good plan.

Since there are no OB firms, we know that

$$p_B + \frac{\gamma-1}{\gamma} b_1^B > b_2^B \tag{20}$$

and because there are no BO firms, we know that

$$p_B + \frac{\gamma-1}{\gamma} b_2^B > b_1^B. \tag{21}$$

Finally because both OO and BB firms exist

$$(p_B - b_1^B)(p_B - b_2^B) \leq 0 \tag{22}$$

with equality only when both terms in parentheses are zero. Thus there may be too many type 1's or too many type 2's without health insurance but not both.

4.2 Calibration

We calibrate the model using information from 1987 and 1996. The choice of dates is driven, in part, by the rapid growth of section 125 plans over this period and, in part, by the availability of data. We obtain much of our data from the 1987 National Medical Expenditures Survey (NMES) and from the 1996 Medical Expenditures Panel Survey (MEPS).

To calibrate the model, we require a functional form for the production function and distributions for the willingness to pay for health insurance. We assume that the production function is CES. We have five zero profit conditions but only three first-order conditions because the compensation costs are the same for two pairs of firm types. In addition, we have two labor market equilibrium conditions. Finally, we require that the distribution of workers in different jobs is consistent with the distribution of tastes which adds four equations.

We thus have fourteen equations in the fourteen endogenous variables (2 wages (w), 3 ratios of high to low skill workers (θ), 5 $L's$, and 4 cutoffs (b)). In addition, we have the equations determining the employee contribution to premiums:

$$\gamma c_{GB} = (v-1)\, b_2^G \tag{23}$$

$$\gamma c_{GO} = b_2^B. \tag{24}$$

There are thirteen parameters which must be chosen in order to calibrate the model. We choose the values of these parameters in the following way.

- Production function parameters: a_1, a_2, ρ. We use $\rho = .8$ which we take from the literature on the elasticity of substitution between skilled and unskilled workers.[4] We derive a_1 and a_2 by imposing that the average wages for type 1 and type 2 workers equal the average earnings of skilled and unskilled workers with employer-provided health insurance and no employee contribution. We calculate these averages from the 1988 and 1997 March Current Population Surveys. The use of data on skilled and unskilled workers is intended to be suggestive. Worker type should not be understood as referring literally to skilled and unskilled workers.

[4] See for example Dougherty (1972).

- Size of labor force: m_1, m_2. m_2 is normalized to 1, and m_1 is equal to the ratio of skilled to unskilled workers in the labor force based on our calculations from the March Current Population Surveys.

- The cost of the good and bad health insurance plans: p_G, p_B. We use the 1987 National Medical Expenditures Survey (NMES) and the 1996 Medical Expenditures Panel Survey (MEPS) to estimate the average total premium for insurance obtained through employers We limit the sample to current private sector employees.[5] The ratio of p_G to p_B is estimated as part of the calibration exercise. We impose that the price of the bad plan rise at the rate of increase in the CPI for medical expenditures but allow the price of the good plan to rise faster or more slowly.

- Distribution parameters: μ_1, μ_2, σ_1, σ_2. We assume that the distribution of willingness to pay within each group is log-normal and choose the mean and variance of each distribution to fit the two cutoffs for that group. We impose that the variances are constant across years and that the μ's increase by .562 to correspond to the 75.4% increase in the medical care component of the CPI over the period.

- Restrictions from health insurance data: From the NMES and MEPS, for private-sector workers, we obtain the offer rate, the take-up rate, the fraction of workers who are offered multiple plans and the average employee contribution among those making a contribution. We impose that our model match these values in each year.

These restrictions are sufficient to allow us to estimate the remaining parameters. Table 1 shows the values used in estimating the parameters. Details of our calculations and data sources are included in the data appendix. The column labelled "1996a" is based on data from the published 1996 MEPS which we believe to be

[5] For 1987, we are unable to eliminate state and local government workers from the sample.

most consistent with our NMES estimates for 1987. Our estimate of the offer rate is somewhat low relative to estimates elsewhere in the literature. Using the same data set (but different sample restrictions), Cooper and Schone (1997) estimate offer rates about five percentage points higher in both years. Using CPS data Farber and Levy also get higher offer rates but show a decline (about two percentage points) in the offer rate from 1988 to 1997.[6] Take-up rates from all three sources are similar for 1986 (1987 in Farber and Levy) but Farber and Levy show a somewhat larger decline (about three percentage points) while Cooper and Schone show a much larger decline (eight percentage points). The net result of the differences is that our estimates show coverage as more or less constant over the period while the other two sources suggest an important drop in coverage. We focus on our estimates as inputs since these are less favorable to our model.[7]

However since there may be some concern that our results reflect some unusual aspect of our underlying coverage estimates, we also pursue a second strategy. We take the average of the estimated decline in the take-up rate from Cooper/Schone, Farber/Levy and our calculations (4.5 percentage points) and adjust our 1987 calculation by this change to get an estimate for 1996. We do the same for the offer rate for which we calculate a 1.3 percentage point increase. This results in about a two percentage point drop in the coverage rate over the period. These data assumptions are shown in the column labelled 1996b.

The only other source we found for the offering of multiple plans were the Kaiser/HRET surveys (Kaiser Family Foundation, 2003). This also shows a large increase in offerings of multiple plans over this period, going from 53% of covered workers in 1988 to 67% of covered workers. After adjusting for coverage, this is a slightly larger increase than in our data.

[6] This refers to the offer rate at the individual level which is the product of the probability of being in a firm offering health insurance and the probability of being eligible for that insurance conditional on being in the firm.

[7] Bernard and Selden using the same data sets find a constant offer rate for their samples and a 2.7 percentage point decline in private coverage from all sources.

Before turning to the estimated parameters, we note that the data suggest very strong differences in the tastes of type 1 and type 2 workers. In our model, only workers in GB firms are offered multiple plans. Thus in 1996, 37.8% of workers are in these firms, and type 1 workers are getting good health insurance and type 2 workers are getting bad health insurance. Only type 2 workers in GO firms turn down health insurance. Since in 1996, 14.5% of the 70.3% of workers offered health insurance turn it down 10.2% of workers are type 2 workers in GO firms and are matched with type 1 workers getting good insurance. Since 54% of workers are type 2 workers, this means that if there were no substitutability among workers, 18.9% of all workers would be in GO firms. Finally, we know that 29.7% of workers are in OO firms in 1996. This leaves less than 14% of workers to allocate between GG and BB firms.

Thus, as a rough approximation, we know that at least half of type 2 workers are not willing to pay for even bad insurance and that no more than 14% and probably considerably less are willing to pay for good insurance. In contrast, at least 57% of type 1 workers and probably considerably more are willing to pay for good insurance. Thus we anticipate that our calibration will reveal a sharp difference in the willingness to pay of the two types and that this will be independent of our modeling decisions.

4.3 Estimated Parameters

Table 2 gives the estimated parameters. The first two columns (labelled 1987a and 1996a) use our main data. The last two columns give the results using data showing a bigger drop in the take-up rate and a smaller increase in the offer rate, thereby creating a drop in the offer rate over the period. We focus on the main results.

The results reveal a significant drop in γ between 1987 and 1996. If taken literally as a tax wedge, the implicit marginal tax rate fell from 42% to 33%. As measured by v, good insurance is valued at almost one and one half time the value accorded to bad insurance. The price ratio is about 1.58 in 1987 which is approximately the 75/25 differential both within single insurance plans and within family plans. This price ratio drops to 1.51 in 1996.

We estimate that in 1987, employees in GO firms paid \$1,094 for their employer-provided insurance or a little over 40% of the total premium. In 1996, this estimate is 50%. Workers who purchased good insurance in GB firms paid \$415 in 1987 or 43% of the price differential between the two insurances. This also rose to 50% in the later period.

As anticipated, the results suggest a strong dichotomy between type 1 and type 2 workers. The estimated distributions of willingness to pay for health insurance imply that almost no type 2 workers value health insurance at its cost. Only a tiny fraction of type 2 workers in the upper tail of the distribution would pay for even bad health insurance if required to pay its full price. In contrast, there is considerable variation in willingness to pay among type 1 workers. In each year, those with valuations no lower than about one standard deviation below the mean would pay the full price of good insurance. There is also a small group willing to pay the full price for bad health but not good health insurance.

If γ were equal to 1, almost all workers would be in GO, BO and OO firms with only minuscule numbers in GG and BB firms. Therefore, given the parameter estimates, GB firms do not arise because there are type 1 workers willing to pay for bad insurance who must be mixed with type 2 workers willing to pay for good insurance. Instead some firms offer a GB combination because it is cheaper to give bad insurance for free than to charge the large employee premium required to deter type 2 workers from buying good health insurance when their only alternative is no insurance.

The tax wedge leads to considerable inefficiency. Using the 1996 results, type 1 workers who get bad health insurance would be willing to pay an additional amount of around \$1,800 for good health insurance while the additional premium is only \$1,460. Type 1 workers without health insurance would be willing to pay up to \$5,270 for good health insurance which costs employers \$4,370.

In contrast, since almost no type 2 workers are willing to pay for even bad insurance, we know that those receiving the insurance value it at less than its price. The 1996 estimates imply that very few type 2 workers get good health insurance, but those who do value it at as little as \$3,550, almost \$1,000 less than its cost. A very substantial fraction of type 2 workers get bad health insurance and value it at about \$630 less than its cost.

The results using the "b" parameters are similar. We show a somewhat larger decline in the tax wedge. There is almost no variation in willingness to pay for insurance among type 2 workers while the variation among type 1 workers is larger than in the main set of estimates. However, overall the differences are modest. In the remainder of the paper, we restrict the analysis to the main set of estimates.

4.4 Comparative Statics

As noted above, if γ equalled 1, almost all type 2 workers would have no health insurance. Type 1 workers would primarily receive good health insurance but some would choose bad health insurance and others no insurance. Thus the vast majority of firms would be GO firms but there would also be some BO and some OO firms. For simplicity we perform our comparative statics treating this as the exact equilibrium.

In contrast to the equilibrium when γ is greater than 1, the equilibrium when γ equals 1 is fully efficient. However, it is important to distinguish between the efficiency implications of lowering γ and the effect on insurance coverage. Based on the 1996 parameters, in the efficient equilibrium, a little over 80% of type 1 workers receive the good insurance for free, 6% get the bad insurance for free and the remainder are employed in firms not offering insurance. Thus while the offer rate would be over 80% if γ equalled 1, the coverage rate would be would fall to about 40% from about 60%. Using the 1987 parameters, when γ equals 1, virtually all workers are in either GO or BO firms. The drop in coverage from reducing γ to 1 is even greater based on the 1987 parameters than based on the 1996 parameters.

Lowering γ also benefits some workers at the expense of others. If γ equalled 1, in 1996, type 1 workers with good insurance would have earned \$47,106 net of their payment of \$4,370 for the full cost of insurance. This net wage exceeds the net wage of type 1 workers receiving the good insurance for free when γ is 1.50. However, the wage received by type 1 workers who do not get insurance declines. Moreover, type 2 workers are better off. They earn \$30,359 which is a little over \$300 more than the wage received by type 2 workers without health insurance in the original calibration.

The 1987 estimates are similar to those obtained using the 1996 parameters. Lowering γ to 1 continues to make the type 1 workers who want good health insurance better off. Type 1 workers receive a wage of \$34,513 from which they pay \$2,600 for good insurance. As with the 1996 estimates, this net wage exceeds the wage received by workers receiving insurance for free in the original calibration. The gross wage is less than the wage received by those who do not get insurance in the original calibration so that type 1 workers who do not get health insurance are worse off. Moreover, based on the 1987 parameters, the reduction in the tax wedge makes type 2 workers who do not get health insurance better off. The wage for type 2 workers without health insurance rises from \$22,968 to \$23,158.

4.5 Understanding Changes in the Offer and Take-up Rates

Since type 2 workers do not want to buy insurance, the issue for firms is, in a sense, to determine the least expensive way to provide insurance to type 1 workers. It may be least expensive simply to give everyone good insurance, to give all workers bad insurance so that those with a greater willingness to pay can purchase good insurance at a relatively modest premium or to require a relative high premium which discourages type 2 workers from getting insurance.

The results indicate that the trade-off is between the last two approaches, and they are close substitutes. Relatively modest changes in parameters can generate large offsetting shifts in the number of GB and GO firms. Thus we calculate that had γ equalled its 1996 value (1.50) in 1987 rather than the actual 1.71 and had no other parameters changed, GB firms would have been eliminated, and the economy would consist of only BB, GO and OO firms. Conversely, if the 1.71 value had held in 1996, the GO firms would have been eliminated.

Why then did the number of GB firms rise? We attribute this to the rise in the ratio of skilled workers to unskilled workers. As the number of workers who want health insurance rises, the model reveals a shift from GO to GB firms. Holding everything else constant at the 1987 rate but increasing the ratio of type 1 to type 2 workers from its 1987 to its 1996 rate eliminates the GO firms.

In essence, when type 2 workers do not place much value on insurance, the primary issue is whether it is cheaper to provide bad insurance to type 2 workers and provide good insurance to type 1 workers at a low price or whether it is cheaper not to provide the bad insurance and charge a high price for the good insurance. When the number of type 2 workers relative to type 1 workers is sufficiently high, it is cheaper to charge the high price. When the tax wedge is sufficiently high, it is cheaper to provide the bad insurance.

The simple model cannot capture the myriad of changes that took place in the health insurance market over this period. In addition to the changing tax wedge which we have emphasized, there was a significant increase in HMO's over this period. One interpretation of the rise of HMO's is that they provided a mechanism for offering a better "bad plan." Yet, we have imposed that the value of the good plan stayed constant relative to the good plan.

We can get some sense of the importance that HMO's may have had by allowing v to rise and examining the change in the equilibrium. We set to 1.48 instead of 1.46 in 1996 and reduce the μ's by $\ln(1.48/1.46)$ to keep the mean willingness to pay for the good plan constant. Overall, as measured in this way, the introduction of HMO's generates a shift towards GB and BB firms and away from GG, GO and OO firms. It therefore increases the offer rate, the number of firms offering choice and increases the take-up rate.

5 Extensions

It is unduly restrictive to assume that there are only two classes of workers and that willingness to pay for health insurance is exogenous. However, relaxing these assumptions makes the model very complex. As a consequence, we rely on numerical examples to show the generality of our results.

5.1 Multiple types of workers

Our example assumes a CES production function of the form

$$q = .5(L_1^{.5} + L_2^{.5} + L_3^{.5})^2. \tag{25}$$

The price of insurance is .2. Willingness to pay for insurance is uniformly distributed between 0 and an upper value of 1, .5 and 1/3 for the three types. We find the equilibrium for γ equal to 1.1 and to 1.2. In both cases, there are four types of offers in equilibrium: one in which all three types get insurance for free, one in which the first two types pay for insurance and the third chooses not to purchase it, one in which only the first type chooses to purchase insurance and one in which insurance is not offered.

As in the base model, at the lower γ, the employee premium is higher at each type of firm and more firms charge for health insurance. However, the overall increase in the average employee premium, conditional on the employee premium being positive, is small because there is a much bigger increase in the proportion of employees paying the lower premium (at the firms where both type 1's and type 2's purchase insurance). In the example, both type 1's and type 2's have higher coverage rates at the lower γ, but overall coverage declines because of a sharp decline in the coverage of type 3's.

5.2 Endogenous insurance demand based on earnings

In this example, we assume that willingness to pay is composed of a nonstochastic term equal to $.02 + .01w$ and a stochastic term distributed uniform on the unit interval. The wage is measured as the wage net of the employee cost of health insurance. The production function is given by

$$q = .5(4\theta^{.5} + 1)^2. \tag{26}$$

The price of health insurance is .25. We set γ equal to 1.4 and 1.2.

In both equilibria, w_1 is about 7.5 higher than w_2 which is sufficient to ensure that all three types of offers exist in equilibrium. Consistent with the exogenous willingness to pay model, lowering γ increases c and γc, increases the number of type B firms and reduces the number of type A and type C firms.

6 Conclusion

This paper makes a number of points which we believe to be important. The first few are methodological:

1. The dichotomy between the multiple plan/fixed subsidy and the imperfect sorting explanations for employee contributions is false. Offering multiple plans can be a way to reduce the cost of deterring low-valuation employees from taking good insurance. Indeed firms will only offer multiple plans if sorting is imperfect. With perfect sorting, firms should offer workers' preferred plan for free.

2. One must be very cautious in interpreting instrumental variables (and OLS) estimates of the determinants of the demand for health insurance. If, for example, we use the state tax rate as an instrument for the effect of the tax price, then the reduced form is picking up the sort of issues emphasized in this paper, that is the comparative statics of a change in the tax wedge. On the other hand if we use nonlinearities in the tax system to identify the effect of the tax price, it is difficult to interpret the estimates. In case this is not obvious, suppose that the production function as Leontief and willingness to pay in pre-tax dollars was the same for all types of worker. Then all firms would either

offer insurance for free or not provide it. The estimated sensitivity of health insurance coverage to the tax price would be zero. This is the right answer if we want to know the effect of making employee premiums tax-deductible but the wrong answer if we want the effect of removing the tax deductibility of employer-paid premiums.

3. If we want to measure the underlying demand for health insurance, we must simultaneously model the distribution of health insurance provision, employee premiums and wages. The cost to a worker of employer-provided health insurance is not only his or her share of the premium but the effect on the wage. Given the difficulties in estimating compensating differentials (Brown, 1980), this is perhaps a hopeless task. In any event, recognizing the endogeneity of matching limits the availability of instruments because, in contrast with standard supply and demand models, factors affect supply are not appropriate instruments in the demand equation and vice versa (Kahn and Lang, 1988). Perhaps more significantly it means that we must use great caution in interpreting "natural experiments" at the firm level. If adjustment is slow so that during the course of the "experiment" the stock of workers at the firm is constant, then eliminating the tax wedge as in Gruber and Washington (2003) must increase the take-up and coverage rates. However, we have seen that this need not be the case when equilibrium is restored.

While we do not take the details of our calibration too seriously, we believe that both the theory and the calibration underscore important messages. Most clearly and significantly, the effects of tax policy on employer-provided health insurance are likely to be complex. The theoretical effect on the coverage rate of making employee premiums tax-deductible is unsigned, and there is good reason to believe that it lowers coverage. It also has large distributional effects. Such tax-deductibility is likely to increase coverage in high demand (and high income) groups and lower coverage in low income groups. It may also increase wages among workers receiving health insurance in these groups. While the policy is efficient, at least if we ignore the effect on government revenue, there are winners and losers.

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A Appendix - Base Model

A.1 General results

Lemma 1 *There cannot be an equilibrium in which a firm offers $c > 0$ and all workers in that firm purchase health insurance.*

Proof. Suppose a firm offers $\{w_1, w_2, ..., w_N, c\}$ with $c > 0$ and all workers take health insurance. It could offer $(w_1 - \gamma c, w_2 - \gamma c, ..., w_N - \gamma c, 0)$, attract the same workers and make more profit. ■

Corollary 4 *All firms in which all workers receive insurance must offer the same wages.*

Lemma 2 *At all firms offering $c^* \neq 0$, workers of a given type at that firm either all take or all refuse health insurance.*[8]

Proof. Suppose some workers of type i pay c^* and receive insurance and some do not pay and do not receive insurance. Workers of type $j \neq i$ either all pay c^* or all do not pay c^*. If $c^* < p$, then setting $c = c^* + \Delta > c^*$, $w_j = w_j^* + \gamma\Delta$ for all types purchasing insurance, and $w_j = w_j^*$ for all types not purchasing health insurance and $w_i = w_i^* + \varepsilon$, $\gamma\Delta > \varepsilon > 0$, would attract all of the workers of type $j \neq i$ that the original firm attracted (and possibly additional workers) but only workers of type i who do not purchase insurance. For Δ and ε sufficiently small, this must be profitable. For $c \geq p$ lowering c and lowering wages by γc for groups in which at least some workers purchase health insurance will yield more profit. The argument applies equally if more than one type has some workers who purchase and some who do not purchase insurance. ■

[8] Ignoring sets of measure zero.

Lemma 3 *Let A represent an offer for which a set M_A pay c_A for health insurance and B represent an offer for which a set M_B pay c_B for insurance with $c_B > c_A$. $M_B \subset M_C$.*

Proof. For types in M_B lowering c_B towards c_A and raising the wage by $\gamma \Delta c$ reduces the employment cost. Types in neither M_A nor M_B will not switch to purchasing insurance since they can already purchase it at c_A and choose not to. Types in M_A but not M_B, employed in A firms value insurance at no more than γc_A and would not switch to the B firm and purchase insurance. ■

A.2 Results for 2 types

Lemma 4 *Offers in which both types of worker receive health insurance for free and offers in which neither type receives health insurance must exist in equilibrium.*

Proof. Suppose not. Then either there are workers of both types who value health insurance at more than its cost and are not receiving it or there are workers of one type who value health insurance at more than its cost and workers of the other type are paying for their health insurance. Offering workers of types not getting health insurance a wage of $w_i - p - \varepsilon$ and workers of the type paying c, $w_j - \gamma c$ and offering health insurance for free will be profitable. The proof of the second part parallels the first. ■

Lemma 5 *In equilibrium there cannot be an offer for which type $1'$s purchase insurance and type $2'$s do not.*

Proof. Suppose such an offer exists. To attract type 2 workers, it must pay $w_2 + \gamma c$ where w_2 is the wage paid to type 2 workers at firms offering health insurance for free and c is the price it charge for health insurance. The firm must attract type 1 workers who value health insurance at less than γc. Therefore it need pay a compensating differential of no more than γc to type 1 workers. Suppose it paid less than γc. Then the highest valuation of health insurance among type 1 workers would be less than γc and the firm could reduce c and the wage it paid type 2 workers and increase its profit. Therefore, the firm pays type 1 workers $w_1 + \gamma c$ where w_1 is the wage paid to type 1 workers by firms offering health insurance for free. For this to be an equilibrium both firms offering health insurance for free and those charging for health insurance must make zero profit

$$\pi_A = f(\theta_A) - (w_1 + p)\theta_A - (w_2 + p) = 0 \tag{27}$$

$$\pi_B = f(\theta_B) - (w_1 + \gamma c)\theta_B - (w_2 + p + (\gamma - 1)c) = 0 \tag{28}$$

which establishes that

$$\gamma c < p \tag{29}$$

$$\theta_B > \frac{m_1}{m_2} > \theta_A \tag{30}$$

where m_i is the measure of type i. Now

$$F_2(p + (\gamma - 1)c) > F_1(p + (\gamma - 1)c) \tag{31}$$

$$F_2(\gamma c) > F_1(\gamma c) \tag{32}$$

and

$$\theta_A L_A = m_1(1 - F_1(\gamma c)) \tag{33}$$
$$L_c = m_2 F_2(p + (\gamma - 1)c) \tag{34}$$

and therefore

$$\frac{m_1}{m_2} L_A > m_1(1 - F_1(\gamma c)) \tag{35}$$

or

$$L_A > m_2(1 - F_1(\gamma c)) > m_2(1 - F_2(\gamma c)) \tag{36}$$

which implies that

$$L_A + L_c > m_2(1 - F_2(\gamma c) + F_2(p + (\gamma - 1)c)) > m_2 \tag{37}$$

which is a contradiction. ■

Proof. of Proposition (1)
From the various lemmas, we know that there are only four candidates for equilibrium offers, one in which both types receive insurance for free (denoted A), one in which neither type receives insurance (denoted C) and two in which one type but not the other purchases insurance from the employer (denoted B if type 1's buy insurance and D if type 2's purchase insurance). B and D offers cannot both exist in equilibrium.

must exist in equilibrium. If not, a firm could offer

Suppose that all four offers exist in equilibrium. Then for type 1's to be willing to apply to both A and B firms, we must have (1)

$$w_1^B = w_1^A + \gamma c^A$$

and

$$v_1^A = w_1^A + p \tag{38}$$
$$v_1^B = w_1^A + (\gamma - 1)c^A + p > v_1^A. \tag{39}$$

where v_i^j is the compensation cost of a type i worker for a type j firm. In order for type 1's to be willing to apply to both C and D firms, we must have

$$v_1^C = w_1^C = w_1^D = v_1^D. \tag{40}$$

Similarly, we have

$$w_2^D = w_2^A + \gamma c^D \tag{41}$$
$$v_2^A = w_2^A + p \tag{42}$$
$$v_2^D = w_2^A + (\gamma - 1)c^D + p > v_2^A \tag{43}$$
$$v_2^B = w_2^B = w_2^C = v_2^C. \tag{44}$$

The middle equality is (3). Since, if $v_1^B > v_1^A$ and $v_2^B > v_2^A$, offer A and offer B cannot both make zero profit, we have

$$w_2^B < w_2^A + p, \tag{45}$$

and since $v_1^C = v_1^D$, we must have $v_2^D = v_2^C$ or

$$w_2^A + (\gamma - 1)c^D + p = w_2^C = w_2^B \tag{46}$$

which implies

$$w_2^B > w_2^A + p \tag{47}$$

and contradicts (45). Therefore only three offers exist in equilibrium.

Let b_2^* represent the highest b of any type 2 at type B firms. If $b_2^* > \gamma c$ some type 2's would choose to purchase health insurance from the firm which is a contradiction. Suppose that $b_2^* < \gamma c$, then lowering both c and w_1^B would be profitable. So $b_2^* = \gamma c$ which is equation (6). But since A jobs offer free health insurance and type 2's do not get insurance at B jobs, the worker type who is indifferent between the two jobs values health insurance at exactly the wage differential or

$$w_2^B - w_2^A = b_2^*.$$

Substituting γc for b_2^* and rearranging terms gives (2).

By a similar argument the wage differential for type 1 workers between working in type A firms and type C firms is b_1^* which is equation (4). ■

Proof. of proposition (2)

The first three conditions follow from combining the zero-profit conditions with the results of the previous proposition. The fourth and fifth conditions ensure that the number of workers employed in firms where they do not receive health insurance equals the correct number of workers of each type.[9] The last three conditions require that the firm hire workers until their marginal product equals their cost of compensation. Because of the constant returns to scale assumption, there is only one condition for each type of firm even though each firm hires two types of worker. ■

Proof. of proposition (3)

Substitute (5), (12) and (13) into (7)-(14), use $\theta_B = \theta_C$, add the two labor market clearing

[9] Without loss of generality given the constant returns to scale assumption, we have treated each offer as being made by a single firm.

conditions and eliminate the two redundant equations to get

$$
\begin{aligned}
&(48) & q(\theta_A, 1) - (w_1 + p)\theta_A - (w_2 + p) &= 0 \\
&(49) & q(\theta_B, 1) - (w_1 + p + (\gamma - 1)c)\theta_B - (w_2 + \gamma c) &= 0 \\
&(50) & \frac{L_C \theta_B}{m_1} &= F_1(p + (\gamma - 1)c) \\
&(51) & \frac{L_A}{m_2} &= 1 - F_2(\gamma c) \\
&(52) & q'_A &= (w_1 + p) \\
&(53) & q'_B &= (w_1 + p + (\gamma - 1)c) \\
&(54) & L_A + L_B + L_C &= m_1 \\
&(55) & L_A\theta_A + L_B\theta_B + L_C\theta_B &= m_2
\end{aligned}
$$

Then fully differentiate with respect to the endogenous variables $w_1, w_{2,} L_A, L_B, L_c, \theta_A, \theta_B, c$ to get

$$
\begin{aligned}
&(56) & \theta_A dw_1 + dw_2 &= 0 \\
&(57) & \theta_B dw_1 + dw_2 + ((\gamma - 1)\theta_B + \gamma)dc + c(1 + \theta_B)d\gamma &= 0 \\
&(58) & m_1 f_1((\gamma - 1)dc + cd\gamma) &= L_C d\theta_B + \theta_B dL_C \\
&(59) & -m_2 f_2(\gamma dc + cd\gamma) &= dL_A \\
&(60) & dw_1 &= q''_A d\theta_A \\
&(61) & dw_1 + (\gamma - 1)dc + cd\gamma &= q''_B d\theta_B \\
&(62) & dL_A + dL_B + dL_C &= 0 \\
&(63) & L_A d\theta_A + (L_B + L_C)d\theta_B + \theta_A dL_A + \theta_B(dL_B + dL_C) &= 0
\end{aligned}
$$

Solving for $d\gamma$ as a function of dc alone gives

$$
(64) \qquad dc = -cd\gamma \frac{(L_B + L_C)q''_A(1 + \theta_A) + q''_B(-m_2 f_2 q''_A(\theta_A - \theta_B)^2 + L_A(1 + \theta_B))}{A}
$$

where $A = ((L_B + L_C)q''_A(\gamma + (\gamma - 1)\theta_A) - q''_B(\gamma m_2 f_2 q''_A(\theta_A - \theta_B)^2 - L_A(\gamma + (\gamma - 1)\theta_B))$

Since $q''_A < 0$, $q''_B < 0$, $\gamma > 1$, $f_2 > 0$,the numerator is negative and A is negative,thus the fraction is positive. The fraction is multiplied by $-c$, so that $\frac{d_c}{d_\gamma} < 0$. ■

Proof. of proposition (4)

$$
(65) \qquad d(\gamma c) = cd\gamma + \gamma dc.
$$

Substituting for dc gives

$$
(66) \qquad d(\gamma c) = -cd\gamma * \frac{(L_B + L_C)q''_A\theta_A + q''_B L_A\theta_B}{A} < 0.
$$

■

Proof. Proof of proposition (5)

$$db_1 = d(p + (\gamma - 1)c) = cd\gamma + (\gamma - 1)dc. \tag{67}$$

Substituting for dc gives

$$\begin{aligned} (68)\ db_1 &= cd\gamma\{1 - (\gamma - 1)\frac{(L_B + L_C)q''_A(1 + \theta_A) - q''_B(m_2 f_2 q''_A(\theta_A - \theta_B)^2 - L_A(1 + \theta_B))}{A}\} \\ (69)\qquad &= cd\gamma\frac{(L_B + L_C)q''_A + q''_B(L_A - m_2 f_2 q''_A(\theta_A - \theta_B)^2)}{A} > 0. \end{aligned}$$

■

Proof. of proposition (6)

$$(70)\quad d(L_B) =$$

$$-cd\gamma\frac{q''_A[\theta_A m_2 f_2(\theta_B L_B + \theta_A L_C) + m_1 f_1(L_B + L_C - m_2 f_2 q''_B(\theta_A - \theta_B)^2)] + L_A[-L_C + q''_B(m_1 f_1 + m_2 f_2 \theta_B^2)]}{\theta_B A} < 0$$

$$(71)\quad d(\theta_B L_B) = \theta_B dL_B + L_B d\theta_B$$

$$= -cd\gamma * \frac{q''_A(\theta_A^2 m_2 f_2(L_B + L_C) + m_1 f_1(L_B + L_C - m_2 f_2 q''_B(\theta_A - \theta_B)^2)) - L_A(L_B + L_C - q''_B(m_1 f_1 + m_2 f_2 \theta_B^2))}{A}$$

$$< 0$$

■

Lemma 6 $\theta_A > \theta_B$

Proof.

$$v_B^1 = w_1 + p + (\gamma - 1)c > w_1 + p = v_A^1$$

and therefore

$$v_B^2 < v_A^2$$

which together implies the lemma. ■

Proof. of proposition (7).

$$d[(1 - F_1(b_1))m_1 + (1 - F_2(b_2))m_2]$$

$$= -cd\gamma\frac{\{m_1 f_1[(L_B + L_C)q''_A + q''_B(L_A - m_2 f_2 q''_A(\theta_A - \theta_B)^2)] - m_2 f_2[(L_B + L_C)q''_A\theta_A + L_A q''_B\theta_B]\}}{A}$$

The right hand side has the same sign as the numerator which proves the necessary and sufficient condition.

If $m_1 f_1 > m_2 f_2 * \theta_A$, then $f m_1 f_1 > m_2 f_2 * \theta_B$ since $\theta_A > \theta_{B.}$ Then

$$m_1 f_1 [(L_B + L_C) q_A'' - m_2 f_2 [(L_B + L_C) q_A'' \theta_A < 0$$
$$m_1 f_1 q_B'' (L_A - m_2 f_2 q_A'' (\theta_A - \theta_B)^2)] - m_2 f_2 L_A q_B'' \theta_B < 0$$

and the numerator is negative which proves sufficiency. ■

Proof. of proposition (8).

>From the solution of fully differential equations:

$$dw_1 = -cd\gamma \frac{q_A''(L_B + L_C + m_2 f_2 q_B''(\theta_A - \theta_B)\theta_B)}{A}$$

$dw_1/d\gamma < 0$ if and only if $L_B + L_C + m_2 f_2 q_B''(\theta_A - \theta_B)\theta_B > 0$.

$dw_2 = -\theta_A * dw_1$ which proves the second part of the proposition. ■

Proof. of proposition (9).

Add dw_1 and db_1 to get

$$dw_1^C = -cd\gamma \frac{q_B''(q_A'' f_2(\theta_A - \theta_B)\theta_A - L_A)}{A} > 0.$$

■

B Appendix: Multiple Plan Equilibrium

We state without proof some results that parallel results for the case with only one type of insurance plan:

1. There cannot be an equilibrium in which a firm offers $c_G > 0$ and all workers in that firm purchase the good health insurance. There cannot be an equilibrium in which a firm sets $c_B > 0$, all workers purchase health insurance and some purchase bad health insurance.
2. In equilibrium there must be firms that offer insurance for free and there must be firms that do not offer insurance (or equivalently offer it at a price at which no worker will purchase it).
3. In equilibrium all workers of a given type at a firm all make the same decision regarding health insurance.[10]

[10] Ignoring sets of measure zero.

As a consequence there are nine possible types of firms. Representing a firm in which type 1 workers and type 2 workers both get good insurance as GG, the possible combinations are GG, GB, GO, BG, BB, BO, OG, OB and OO.

The table below shows the worker compensation cost for each combination of offers. By assumption, if the firm does not charge for G (good) health insurance, the cost is the base wage plus the cost of health insurance. If the firm charges for good health insurance, then the charge must deter purchases by the type that does not want health insurance. Thus in GB firms, the charge must satisfy

$$\gamma c = v b_2^B - b_2^B \tag{72}$$

since vb_2^B is the highest value of good insurance to any type 2 worker getting only bad insurance and v_2^B is the value to them of getting the bad insurance for free while γc is the cost of buying the good insurance. Therefore we have

$$c = b_2^B \frac{v-1}{\gamma}. \tag{73}$$

Type 1 workers must be compensated by γc for the cost of purchasing the insurance so that the net cost to the firm is $(\gamma - 1)c$. Type 2 workers must be compensated for not getting the good insurance and are thus paid $w_2 + (v-1)b_2^G$. The other elements of the table are derived similarly.

Firm Type	Type 1 Compensation Cost	Type 2 Compensation Cost
GG	$w_1 + p_G$	$w_2 + p_G$
GO	$w_1 + p_G + \frac{\gamma-1}{\gamma} v b_2^B$	$w_2 + b_2^B + (v-1)b_2^G$
GB	$w_1 + p_G + \frac{\gamma-1}{\gamma}(v-1)b_2^G$	$w_2 + p_B + (v-1)b_2^G$
BG	$w_1 + p_B + (v-1)b_1^G$	$w_2 + p_G + \frac{\gamma-1}{\gamma}(v-1)b_1^G$
BB	$w_1 + p_B + (v-1)b_1^G$	$w_2 + p_B + (v-1)b_2^G$
BO	$w_1 + p_B + (v-1)b_1^G + \frac{\gamma-1}{\gamma} b_2^B$	$w_2 + b_2^B + (v-1)b_2^G$
OG	$w_1 + b_1^B + (v-1)b_1^G$	$w_2 + p_G + \frac{\gamma-1}{\gamma} v b_1^B$
OB	$w_1 + b_1^B + (v-1)b_1^G$	$w_2 + p_B + (v-1)b_2^G + \frac{\gamma-1}{\gamma} b_1^B$
OO	$w_1 + b_1^B + (v-1)b_1^G$	$w_2 + b_2^B + (v-1)b_2^G$

The following results also parallel the results for the case with only one type of health plan and are stated without proof.

1. Type GO and OG firms cannot coexist.
2. Type BO and OB firms cannot coexist.
3. Type GB and BG firms cannot coexist.

Because of the restriction on the distribution of tastes, there cannot be equilibria in which

1. Type 1 workers only get the good insurance in GG firms but in which either OG or BG firms exist.
2. Type 2 workers only get no insurance in OO firms and OB or OG firms exist.

Lemma 7 *GO and BG firms cannot both exist in equilibrium.*

Proof. Let the cost of a type i worker at a firm of type ab be Q_i^{ab}. Suppose that GG, GO, and BG firms all exist. Offering BO will be profitable if $Q_1^{BO} < Q_1^{GO}$. We know that

$$Q_1^{GO} = Q_1^{GG} + \frac{(\gamma - 1)}{\gamma} v b_2^b \tag{74}$$

where vb_2^b is the highest value placed on good health insurance by any type 2 worker not getting health insurance since such workers would be willing to pay up to $\frac{vb_2^b}{\gamma}$ and the firm must compensate type 1 workers by vb_2^b for the added cost but gets $\frac{vb_2^b}{\gamma}$ from each type 1 worker. An offer of BO would cost

$$Q_1^{BO} = Q_1^{BG} + \frac{(\gamma - 1)}{\gamma} b_2^b \tag{75}$$

by the same logic. But since

$$Q_2^{BG} > Q_2^{GG} \tag{76}$$

we have

$$Q_1^{BG} < Q_1^{GG} \tag{77}$$

so that $Q_1^{BO} < Q_1^{GO}$ and the deviation is profitable. ■

Lemma 8 *Firms offering GB and BO cannot both exist in equilibrium.*

Proof. Suppose that both exist. Then for GO not to be a profitable offer,

$$Q_1^{GO} > Q_1^{BO}. \tag{78}$$

Since

$$Q_1^{GB} > Q_1^{GO}, \tag{79}$$

we have

$$Q_1^{GB} > Q_1^{BO} \tag{80}$$

$$Q_2^{BO} > Q_2^{GB} \tag{81}$$

which implies that

$$b_2^b > p_b. \tag{82}$$

Now since

$$Q_1^{BO} = Q_1^{OO}, \tag{83}$$

we also have

$$b_1^b > p_b. \tag{84}$$

But if b_1^b and b_2^b are both greater than p_b, BB is more profitable than OO which is a contradiction. ■

C Data Appendix

C.1 1987

All health insurance data were obtained from the 1987 National Medical Expenditures Survey. We limited the sample to observations for which TYPEX=1 (the respondent is a worker), for which DATASRCE=1 (the record refers to health insurance potentially obtained through a non-federal employer). All estimates were weighted used POSTJOWT (the worker weight).

- Offer rate: Workers who worked in firms that offered insurance and were eligible for insurance were coded as having been offered insurance by their employer (EPROVINX=1 and ELIGX=1). Missing values of ELIGX due to nonresponse or invalid skips were dropped from the calculation.
- Take-up rate: Workers who held a plan through this employer (HELDOPT = 1 or 3) were coded as having insurance.
- Multiple plan offer rate: Workers who said they were offered two or more plans (CHOICE>1) and who either held insurance through this employer or were eligible for insurance through this employer were coded as having been offered multiple plans and were not coded as ineligible (ELIGX=2).
- Insurance premium: The mean total insurance premium is given by the mean of TOTPREXX.
- Employee contribution: The employer contribution is given by EMPCONXX. We calculated the employee contribution as the difference between TOTPREXX and EMPCONXX.
- Mean wages for workers with employer-provided health insurance and no employee contribution: These were obtained from the March 1988 Current Population Survey. We used total annual earnings. Skilled workers were defined as occupation codes occlyr<300 while unskilled workers were defined as occupation codes occlyr>300.

C.2 1996

All health insurance data were obtained from the 1996 Medical Expenditures Panel Survey. The following data are from the on-line published tables at http://www.meps.ahrq.gov/MEPSDATA/ic/1996/Index196.htm.

- Offer rate: The proportion of private sector employees in firms offering health insurance (Table I.B.2.c) multiplied by the proportion of private sector employees in firms offering health insurance who were eligible for insurance (Table I.B.2.a)
- Take-up rate: The proportion of private sector employees who were eligible for health insurance through their employer who were enrolled in health insurance at that establishment (Table I.B.2.a.(1))

- Multiple plan rate: The proportion of private sector employees working in establishments offering two or more plans (Table I.B.2.c) multiplied by the proportion of workers in the 1987 data set who worked in establishments offering two or more plans and who were eligible for insurance.
- Insurance premium: The average premium for a single plan (Table I.C.1) and the average premium for a family plan (Table I.D.1) weighted by the proportion of workers with health insurance who have a single plan (Table I.C.4)
- Employee contribution: The average employee contribution for a single plan (Table I.C.2) and the average premium for a family plan (Table I.D.2) given a positive contribution weighted by the proportion of workers with health insurance who have a single plan and make a positive contribution (Table I.C.4).

Mean wages for workers with employer-provided health insurance and no employee contribution were obtained from the March 1997 Current Population Survey.

TABLE 1
KEY DATA USED IN CALIBRATION

	1987	1996a	1996b
Offered Insurance	67.5%	70.3%	68.8%
Offer Multiple Plans	30.4%	37.8%	37.1%
Take-Up Rate	87.8%	85.5%	83.3%
Average Premium	$1958	$3653	$3653
Average Employee Premium if >0	$617	$1188	$1188
Wage Type 1 Workers with Free HI	$32650	$47660	$47660
Wage Type 2 Workers with Free HI	$21690	$27670	$27670
ρ	0.8	0.8	0.8
Ratio of Type 1 to Type 2 Workers	.751	.874	.874
Growth Rate of Mean Valuation of Insurance	0	75.4%	75.4%
Price Increase of Bad Insurance Relative to 1987	0	75.4%	75.4%

TABLE 2
ESTIMATED PARAMETERS FROM CALIBRATION
(all dollar figures are in thousands of dollars)

	1987(a)	1996(a)	1987(b)	1996(b)
γ	1.71	1.50	1.73	1.44
v	1.46	-	1.41	-
a_1	14.96	21.11	14.95	21.36
a_2	10.63	12.79	10.63	12.80
p_G	2.60	4.37	2.63	4.08
p_B	1.65	2.89	1.63	2.86
b^G_1	2.73	4.04	3.17	3.62
b^B_1	2.13	3.61	2.09	3.55
b^G_2	1.54	2.43	1.79	2.26
b^B_2	1.28	2.26	1.29	2.26
θ_{GG}	0.89	1.04	0.88	1.02
θ_{GB}	0.80	0.95	0.80	0.94
θ_{OO}	0.69	0.79	0.70	0.80
L_{GG}	*	0.04	*	0.09
L_{GB}	0.29	0.36	0.30	0.36
L_{BB}	0.22	0.09	0.22	0.01
L_{GO}	0.14	0.19	0.14	0.22
L_{OO}	0.34	0.31	0.34	0.33
μ_1	0.95	1.52	1.07	1.63
μ_2	0.25	0.81	0.25	0.82
σ_1	0.40	-	0.67	-
σ_2	0.04	-	0.0002	-
c_{GB}	0.41	0.74	0.43	0.65
c_{GO}	1.09	2.20	1.06	2.23
w_1	31.40	46.42	31.33	47.52
w_2	20.98	26.65	20.95	26.92

- Constrained to be the same in the two years

* Approximately zero