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Three essays on insurance choice

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Three essays on insurance choice

by

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For Lisa

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Three essays on insurance choice

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The first chapter of this dissertation investigates the consequences of the Emergency Medical Treatment and Active Labor Act (EMTALA). While the law has been in effect since 1986, this chapter is the first study of the law by an economist that this author has been able to find. I find that the medical insurance rate would have increased without passage of this law.

The second chapter of this dissertation considers the tax subsidy of medical insurance in the United States. Employer-provided medical insurance is exempt from income taxes. Previous studies have focused on how this subsidy effects the average likelihood of having insurance. The innovation of this chapter is to estimate the *actual number* of workers who would drop insurance coverage were the tax subsidy be removed.

The third chapter looks at a different kind of insurance—unemployment insurance. The generosity of unemployment insurance varies greatly across countries, and even across time within the United States. The third chapter attempts to understand these differences, and in doing so, estimates an important parameter of the labor-search literature.

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Chapter 1

Bankruptcy, Medical Insurance and a Law with Unintended Consequences

Two potentially related empirical phenomena have recently perplexed economists. The first is the rise of consumer bankruptcy in the US. The number of consumer bankruptcies in the US has risen since the mid-1980s. This change has typically been explained by changes in transaction costs, or decreased "stigma" associated with bankruptcy.

At the same time, the number of workers with medical insurance has declined. Cutler (2002) focuses on this decline in the late 1980s and 1990s. Cutler (2002) finds that this is due entirely to the decline in the take-up rate of private medical insurance. The proportion of full-time workers offered private medical insurance from their employer over this period did not change, while an increasing proportion of those who were offered insurance did not accept it.

In fact, this decline in the insurance rate seems to have begun in the mid-1980s. As reported in Gruber and Poterba (1994a), the insured proportion of the employed population has decreased since 1986. These trends can be seen in Figure 1.1.

In 1986, the Emergency Medical Treatment and Active Labor Act (EMTALA) passed into law. Also known as the "Patient Anti-Dumping Law," it guaranteed a standard of care to any person who showed up in a hospital's emergency room, independent of the person's insurance status or ability to pay for medical care.[1] Before 1986, a hospital could turn away a patient if the patient was unable to pay for care.

Unfortunately, as reported by the Government Accountability Office (2001), there is no data on the incidence of "patient dumping." However, the effect on incentives is clear. Before 1986, medical insurance was one way to ensure medical treatment. After 1986, a standard of care was guaranteed by law. *Ipso facto*, private medical insurance becomes less valuable with EMTALA because bankruptcy became a more agreeable substitute. If an uninsured individual suffers a costly medical emergency, he or she is guaranteed a standard of care and can default on the payment of medical bills.

This paper first examines these empirical phenomena—the declining insurance rate and the increased number of consumer bankruptcies. Then, I introduce a model that mixes the insurance choice with the default choice. This model is then taken to medical expenditure data, in order to estimate the quantitative effects of EMTALA. The final section concludes.

[1] If a hospital is found in violation of EMTALA, it could lose its payment agreements for Medicare and Medicaid.

1.1 Two Empirical Phenomena

1.1.1 Declining Insurance

The 1990s saw a large increase in medical costs, as described in Figure 1.6(a). At the same time, the take-up rate of those workers offered private medical insurance declined. Cutler (2002) finds that the rise in out-of-pocket (OOP) premia can account for the entire fall in take-up rates. This pattern is consistent with models of adverse selection.

Low-income workers in the 1990s were much less likely to have medical insurance. Cutler (2002) suggests why this might be: "The alternatives that people have—enrolling in public programs, receiving free care, or paying out of pocket—are not equally attractive to everyone, particularly higher income people."

Figure 1.1 demonstrates that the decline in insurance rates began in the mid-1980s. In particular, there was a significant decrease around 1986. As Table 1.1 shows, low-income workers disproportionately shifted out of medical insurance after 1986.

In 1986, there were several changes in federal law that could have affected demand for medical insurance. The first was the Tax Reform Act (TRA) of 1986. While TRA decreased the top marginal income tax rate, TRA increased the marginal tax rate on some low-income workers from 11% to 15%. Since compensation in the form of insurance is tax-exempt, this made wage income more expensive for low-income workers and medical benefits more attractive. Moreover, TRA extended limited tax-exemptions to the self-employed, increasing the insured portion of the self-employed. These changes mask larger decreases in insurance rates of the non-self employed in Table 1.1 and Figure 1.1.

The Consolidated Omnibus Budget Reconciliation Act (COBRA) of 1986 is well-known among economists and the unemployed. COBRA gave workers the right to purchase group insurance from their employers for a period of time after they left their jobs or were fired. This should *increase* a household's willingness to pay for private medical insurance. After COBRA, having private medical insurance included the option value of purchasing it in the event of job loss.

Also part of COBRA was EMTALA. EMTALA decreased the value of medical insurance, by guaranteeing a standard of care in emergency rooms. Moreover, the patterns of un-insurance described above fit the EMTALA story. The cost of bankruptcy is likely to be much less for low-income households, as low-income households are less likely to hold assets and other property that could be forfeited in the bankruptcy process. As can be expected, the distortions of EMTALA around 1986 were greatest among the low-income households.

1.1.2 The Rise in Bankruptcy

As Figure 1.2 shows, consumer bankruptcy has been on the rise in the US since the mid-1980s. While the the number of consumer bankruptcies reflects some business cycle variation, the trend is positive. Figure 1.2 also shows the number of business bankruptcy filings. The number of business bankruptcies has remained relatively constant over this period. While changes in financial frictions have been used to explain the change in the consumer bankruptcy rate, it is not clear why these effects would be asymmetric. Figure 1.2 suggests an asymmetric change in the bankruptcy choices faced by consumers and businesses.[2]

It has been argued that a decline in the "stigma" of bankruptcy led to the dramatic rise of consumer bankruptcy. Again, there is no *a priori* reason to think that such a decline would only affect consumer bankruptcies. Further, as Sullivan, Warren and Westbrook (2000) notes, non-response remains a large problem in collecting survey data from recently bankrupted households, and does not vary in a

[2]The Tax Reform Act of 1986 also limited the flexibility of large banks to write off bad debt. While no model of bankruptcy includes the tax incentives for lenders, this change would likely be modeled as an increase in the transaction costs of debt.

way that suggests declining stigma. The response rate of bankrupt consumers was nearly fifty percent for their 1991 study. The response rate for Western Texas was ten percent higher than Northern California.

A more recent study, Jacoby, Sullivan and Warren (2001), focused on the role of medical debt and bankruptcy. Twenty percent of the respondents from their 1991 study cited medical "causes" of their bankruptcy, rising to half of the bankrupted consumers in their 1999 study. Two percent cited medical reasons in their 1981 study. Sullivan et al. (2000) report that the average and median income of their bankrupt respondents decreased from 1981 to 1991. As shown above, low-income households were more likely to have switched out of coverage.

Some of the most striking evidence in favor of EMTALA's role is anecdotal. The first is from the Government Accountability Office (2001), which studied the effects of EMTALA for Congress. Doctors reported that EMTALA led to increased use of emergency rooms, which was aggravated by the rising number of uninsured patients. Further, the study noted, "EMTALA leads to on-call physicians providing uncompensated care."[3]

Jacoby et al. (2001) also finds evidence of strategic behavior in decisions of debt and medicine:

> "Anecdotally, we have heard from bankruptcy lawyers that debtors may be reluctant to risk losing the services of their health care providers and thus may try to find a way to pay them even if other creditors go unpaid."

Livshits, MacGee and Tertilt (2006) finds that the Canadian bankruptcy rate demonstrates a similar pattern to that of the US. The Canadian bankruptcy

[3] Later the study states, almost suggestively, "Hospital and physician representatives also told us that EMTALA has contributed to the increased use of emergency departments for the treatment of nonurgent conditions and a decline in physicians willingness to provide on-call services to emergency departments. However, other factors, such as the increase in the number of uninsured, also contribute to these changes and it is difficult to determine how much is due to EMTALA."

rate serves as a control group for their research. The Canadian legal and credit market institutions are similar to those of the US. Since medical care is socialized in Canada, similar growth rates cannot be explained by increased exogenous medical risk in both countries. This similarity does not begin until the early- to mid-1990s. The bankruptcy rate in Canada experiences a shallow trough in the mid- to late-1980s, while the US rate exhibits rapid growth. Decreasing transaction costs may help explain the similar growth in consumer bankruptcy in these two countries in the 1990s. However, the data are consistent with an asymmetric change in the mid- to late-1980s.

These phenomena point to a change in 1986. After 1986, insurance rates in the US begin to decline, and the number of medically-related consumer bankruptcies increased. As the insurance rate fell, the price of insurance increased. The following sections explain these patterns with an adverse selection model of insurance and default.

1.2 A Model of Insurance and Default

The economy described below has a unit measure of agents heterogeneous in their risk. It is assumed that agents' risk types are private information. This assumption is drawn from the many legal mechanisms designed to ensure the privacy of health information. For example, the Health Insurance Portability and Accountability Act (HIPAA) of 1996 mandated federal privacy protections for patients. Further, it is assumed that signaling is not possible.

These assumptions lead to adverse selection in the medical insurance market. The agents who choose medical insurance are those who are most likely to use it. This is consistent with a wide array of medical insurance research. For example, Cutler and Zeckhauser (1998) finds that adverse selection led to the collapse of the most generous medical insurance plan offered by Harvard University.

1.2.1 The Agent's Choice

Consider an agent that faces risk $\widetilde{mx}_i$. This risk is characterized by its PDF and CDF, $h_i(mx), H_i(mx)$. *Ex ante*, before this risk is realized, the agent can purchase insurance against this risk, $\iota = 1$, at price ϖ. After the risk is realized, *ex post*, the agent without insurance can choose to default, $d = 1$, at price κ. All agents earn income w and each makes the ex-ante insurance choice according to:

$$U_I(w, \widetilde{mx}_i; \varpi, \kappa, \tau) = \max_{\iota \in \{0,1\}} \left\{ u(w - \varpi - \tau), E\left[\widetilde{U}_D\right] \right\}. \tag{1.1}$$

Agents are taxed a lump sum amount τ; the proceeds of this tax pay for the realized risk that is defaulted on. This is the insurance choice framework of Pratt (1964), with the additional opportunity to default on the realized risk *ex post*.

The utility of going uninsured is a random variable:

$$\widetilde{U}_D = \left[\max_d \{u(w - \widetilde{mx}_i - \tau), u(w - \kappa - \tau)\}\right]. \tag{1.2}$$

If the realized $mx_i > \kappa$, then the agent chooses to default. Otherwise, the agent will pay for realized risk out of pocket.

An agent's willingness to pay for medical insurance, π_i, depends upon its risk, $\widetilde{mx}_i$, the cost of default, κ, and the tax level τ: $\pi(\widetilde{mx}_i; \kappa, \tau)$. If household i's willingness to pay for private medical insurance is greater than or equal to its price, i.e., $\pi(\widetilde{mx}_i; \kappa, \tau) \geq \varpi$, then the household will choose to buy insurance, $\iota(\widetilde{mx}_i; \kappa, \tau) = 1$.

1.2.2 The Markets for Insurance and Medical Care; the Government

The insurance market is competitive, so that the price of insurance is equal to the average realized risk of the insured. By the informational assumptions, there is only one insurance type offered.

Medical goods and services are provided by firms with linear technology that converts consumption goods into medical goods. In order to ensure the existence of medical firms, the government collects the lump-sum tax on households, and redistributes this revenue to the hospitals in order to cover the lost revenue due to defaults.

1.2.3 Equilibrium and Stability

Definition. An equilibrium is defined to be a price of insurance, ϖ, tax level, τ, default decision rule $d(mx_i; \kappa, \tau)$ and insurance decision rule $\iota(\widetilde{mx}_i; \kappa, \tau)$ such that:

- ι_i solves the household's insurance choice, according to the discrete maximization problem of (1.1);
- $d(mx_i; \kappa)$ solves the household's default choice, according to the discrete default problem of (1.2);
- ϖ is equal to the average realized risk of the insured;
- and τ is set to expected amount of realized risk which is not paid for by agents due to default.

Several reasonable assumptions specify the model to make it consistent with empirical evidence and tractable:

- The unconditional distribution of realized medical uncertainty is Pareto of the second kind (a.k.a. Lomax or Pearson Type IV).
- Individual i's risk is characterized by the exponential distribution, with parameter λ_i. If the λ_i's are distributed according to the gamma distribution, then the unconditional distribution of realized risk will be Pareto. This identity is derived in Harris (1968).

- Preferences display constant absolute risk aversion (CARA).

Under these assumptions, an agent's willingness to pay for medical insurance with the availability of default is:

$$\begin{aligned}\pi(\lambda_i;\kappa) &= \frac{1}{r}\log(Pr(mx_{\leq}\kappa) * E(e^{-r*\widetilde{mx}_i}) + Pr(mx_i < \kappa)e^{-r\kappa}) \\ &= \frac{1}{r}\log\left(\frac{\lambda_i - re^{-(\lambda_i - r)\kappa}}{\lambda_i - r}\right)\end{aligned}$$

Note that an agent's willingness to pay does not depend upon the tax level. The following results are important for the equilibrium results below. It is helpful to note that agents with lower λs face higher risk: the mean of an exponential random variable parameterized by λ is λ^{-1}.

- $\lim_{\lambda_i \to 0} \pi(\lambda_i;\kappa) = \kappa$, and $\lim_{\lambda_i \to 0} \pi(\lambda_i;\kappa) < 0$;
- $\lim_{\lambda_i \to \infty} \pi(\lambda_i;\kappa) = 0$, and $\lim_{\lambda_i \to \infty} \pi(\lambda_i;\kappa) = 0$
- $\lim_{\lambda_i \to r} \pi(\lambda_i;\kappa) = \frac{1}{r}\log(1+r\kappa)$, with $0 < \pi(r;\kappa) < \kappa$, and $\lim_{\lambda_i \to r} \pi(\lambda_i;\kappa) < 0$

Theorem (Monotonicity of willingness to pay)**.** *For* $\kappa > 1$

$$\frac{\partial \pi(\lambda_i;\kappa)}{\partial \lambda} < 0.$$

An informal sketch of intuition. The following inductive proof is structured as follows: first, establish that $\frac{\partial \pi(\lambda_i;\kappa)}{\partial \lambda}|_{\lambda=r} < 0$. Second, for any $\lambda_0 > r$, $\frac{\partial \pi(\lambda_i;\kappa)}{\partial \lambda}|_{\lambda=\lambda_0+\epsilon} < 0$

Since $\frac{\lambda_i - re^{-(\lambda_i - r)\kappa}}{\lambda_i - r} > 1$ the sign of $\frac{\partial \pi(\lambda_i;\kappa)}{\partial \lambda}$ depends upon the sign of:

$$\frac{\partial}{\partial \lambda_i}\frac{\lambda_i - re^{-(\lambda_i - r)\kappa}}{\lambda_i - r} = \frac{1 + r\kappa e^{-(\lambda_i - r)\kappa} - \frac{\lambda_i - re^{-(\lambda_i - r)\kappa}}{\lambda_i - r}}{\lambda_i - r}$$

The sign of equation 1.3 depends upon the two inequalities $\lambda \gtrless r$, and $f(\lambda) = 1 + r\kappa e^{-(\lambda_i - r)\kappa} \gtrless \frac{\lambda_i - re^{-(\lambda_i - r)\kappa}}{\lambda_i - r} = g(\lambda)$.

Using L'Hospital's Rule, it can be shown that if $\kappa > 1$:

$$\frac{\partial f(\lambda)}{\partial \lambda}|_{\lambda=r} = -r\kappa^2 > -\frac{r\kappa^2}{2} = \frac{\partial g(\lambda)}{\partial \lambda}|_{\lambda=r}.$$

For a small $\epsilon > 0$, $f(r+\epsilon) < u(r+\epsilon)$, implying that $u'(r+\epsilon) < 0$. This implies that for a small ε, $f(r+\epsilon+\varepsilon) < u(r+\epsilon+\varepsilon)$, implying that $u'(r+\epsilon+\varepsilon) < 0$.

Mutatis mutandis, for a sequence of small negative numbers. □

The monotonicity of $\pi(\lambda;\kappa)$, and the fact that $\lim_{\lambda\to 0}\pi(\lambda;\kappa) = \kappa$ implies that even the agent facing the highest risk would rather purchase insurance rather than default with perfect certainty.

This monotonicity allows us to draw the supply and demand curves as downward sloping. Because of this, an equilibrium can be characterized by one marginal agent, whose willingness to pay for insurance is equal to its price. For a marginal agent, λ_m, the average expenditure of the insured is:

$$\begin{aligned} \varpi(\lambda_m) &= \int_0^{\bar{\lambda}_m} t^{-1} \frac{t^{\alpha} e^{-t/\beta}}{\beta^{\alpha+1}\Gamma(\lambda_m/\beta, \alpha+1)} dt \\ &= \frac{\Gamma(\lambda_m/\beta, \alpha)}{\beta\Gamma(\lambda_m/\beta, \alpha+1)}, \end{aligned} \tag{1.3}$$

where $\Gamma(x, \alpha)$ is the incomplete gamma function. Three characteristics of the price schedule of insurance, $\varpi(\lambda_m)$ will be important:

- $\lim_{\lambda_m\to\infty}\varpi(\lambda_m) = \frac{1}{\alpha\beta} > 0$,
- $\lim_{\lambda_m\to 0}\varpi(\lambda_m) = \infty$, and
- $\frac{d\varpi(\lambda_i)}{d\lambda_i} < 0$.

The probability of an uninsured agent of type λ_i choosing bankruptcy is $P(mx > \kappa|\lambda_i) = e^{-\kappa\lambda_i}$. Then the mass of agents who go bankrupt are:

$$\int_{\lambda_m}^{\infty} e^{-\kappa t} t^{\alpha} \frac{e^{-t/\beta}}{\beta^{\alpha+1}\Gamma(\alpha+1)} dt = \frac{\Gamma(\alpha+1) - \Gamma(\lambda_m(1/\beta+\kappa), \alpha+1)}{\Gamma(\alpha+1)(1+\beta\kappa)^{\alpha+1}} \tag{1.4}$$

The average medical expenditure in the economy is

$$\overline{mx} = \frac{1}{\alpha\beta} \tag{1.5}$$

while the variance is given by:

$$\mathrm{Var}(mx) = \frac{\alpha+1}{\alpha^2\beta^2(\alpha-1)}. \tag{1.6}$$

The proportion of agents with medical insurance is the CDF of the gamma distribution evaluated at the marginal agent.

$$||\Lambda_1|| = \mathrm{gammacdf}(\lambda_m; \alpha, \beta). \tag{1.7}$$

Because of the downward-sloping supply curve, there may be multiple equilibria. In order to resolve this, I propose an equilibrium refinement.

Definition. An equilibrium characterized by its marginal agent, λ_m, is locally stable if it can withstand a deviation from equilibrium behavior by an agent local to its marginal agent.

Theorem. *An equilibrium characterized by its marginal agent λ_m is locally stable if for all local $\varepsilon > 0$*

$$\varpi(\lambda_m + \varepsilon) \geq \pi(\lambda_m + \varepsilon; \kappa)$$

and

$$\varpi(\lambda_m - \varepsilon) \leq \pi(\lambda_m - \varepsilon; \kappa)$$

The stability refinement is similar to the trembling-hand refinement of Selten (1975), and the stability refinement of Kohlberg and Mertens (1986). This refinement is intuitive—the equilibria in this model are pooling equilibria. Because the movements in insurance rates and prices are steady, it is unlikely that the equilibria we observe is unstable. Further, stable equilibria produce better fits of the data, as described below.

For reasonable parameter values, $[\alpha, \beta, r, \kappa]$, one of the three cases below characterizes the existence of equilibria:

- no equilibrium exists;
- one instable equilibrium exists; or,
- two equilibria exist, one stable and the other not; the marginal agent of the stable equilibrium faces a lesser risk than the marginal agent of the instable equilibrium.

Figures 1.6, 1.7, and 1.8 plot the price, $\varpi(\lambda)$, and willingness to pay, $\pi(\lambda; \kappa)$, functions for three different parameterizations. There is an equilibrium where the price of insurance equals its value to the marginal agent in Figures 1.6 and 1.7. There is not an equilibrium in Figure 1.8.

The stability of the first two circumstances can be found in Figures 1.9 and 1.10. They demonstrate the previous intuition.

1.2.4 Is this a sensible specification of risk?

Figures 1.3 and 1.4 plot the empirical PDF and CDF of medical charges against the fit of a Pareto distribution. One might naively treat medical charges the same way one would treat other stochastic variables: set up an ARMA process and use the previous period's medical charges as the state variable which determines the risk faced by the agent in the next period. Since the medical expenditures are all non-negative, it would seem natural to fit the ARMA process from the log of the charge data. However, there are a large number of observations with no medical charges. Since the natural log of zero is undefined, it makes little sense to fit the expenditure data to a log-ARMA process.

Note that the empirical PDF is monotonically decreasing with a large tail. This contradicts one implication of the log-ARMA fitting: in the cross-section log-ARMA fits lead to lognormal cross-sections, whose PDFs are not monotonic.

1.2.5 Why CARA Preferences?

Figure 1.6(b) shows medical expenditures as a percentage of GDP leveling off in the 1990s. If preferences exhibited constant relative risk aversion, then the average risk faced by households would not have changed. If the average risk does not change, then the distribution of relative risk likely did not change either. In this case, the degree of adverse selection in medical insurance would not have changed. This is inconsistent with the decline in the insurance rate and the increased bankruptcy rate. Figure 1.6(a) plots the medical expenditures per capita, as they increase across the period. This would be consistent with the declining insurance rates and increasing bankruptcy rates of this period.

Consider two agents facing the same absolute uncertainty. If preferences exhibited constant relative risk aversion, the worker with the higher wage would have a lesser willingness to pay for insurance than the low-wage worker. CRRA preferences exhibit negative income elasticities. This runs contrary to the strong positive association between higher wages and having medical insurance, as exhibited in Table 1.1. A good deal of this positive association is due to the tax-exempt status of medical insurance. Higher-income workers face higher marginal tax rates. This makes medical insurance relatively less expensive than wages. The positive association between wages and insurance can only be partially explained by differing marginal tax rates using sensible price elasticities, such as those estimated in Gruber and Poterba (1994a).

1.2.6 Why is the model static?

In this model, the cost of default is characterized by κ. In previous models of default, the cost of default is derived from two sources: exclusion from the credit market and some utility loss due to the "stigma" of default. The former cost is inherently dynamic and demands a dynamic model.

However, the model here is static. This is because the timing of payments to insurers, both in the model and in the real world, is also static. A previously bankrupted household would not be kept from the insurance market because payment for insurance occurs before insurance pays for medical goods and services. Likewise, there is no incentive for medical providers to deny their goods and services so long as the individual pay for them.

This static model also overlooks the potential option value of medical insurance. If an uninsured employee develops a chronic condition, the insurer may refuse to insure him or her. Starting in 2002, the Medical Expenditure Panel Survey (MEPS—described below), recorded the reason for a worker's ineligibility for medical insurance. Of over twenty-five thousand jobs recorded in the 2002 MEPS, roughly ten percent of the respondents reported that they were ineligible to receive medical insurance. Of these 2,500, only nine incidents of ineligibility were for medical reasons. Over 1,700 respondents were not offered insurance because they did not work enough hours.

The next chapter finds that a demand curve estimated from a one-period insurance choice model is consistent with previous estimates of the compensating differential (i.e., price) for private medical insurance.

1.3 Estimation and Data

The model described above has four parameters to be estimated—α and β, which characterize the distribution of risk in the economy, r, the degree of absolute risk aversion, and κ, the cost of default. These four parameters are estimated using a minimum-distance estimator on five moments from the model. These five moments are:

- cost of insurance, Equation (1.3);
- bankruptcy rate, Equation (1.4);
- average medical charge, Equation (1.5);
- variance of the medical charges, Equation (1.6); and,
- proportion of agents with insurance, Equation, (1.7).

The minimum distance estimator takes the usual form:

$$\phi^* = [\alpha^*, \beta^*, r^*, \kappa^*] = \arg\min(\mu^d - \mu^m(\phi))W(\mu^d - \mu^m(\phi))', \tag{1.8}$$

where μ^d is a vector of the moments from the data, $\mu^m(\phi)$ is a vector of the moments from the model evaluated at parameter values ϕ, and W is a weighting matrix. The inverse of the variance-covariance of the moments is used as the weighting matrix. Due to restrictions of the data below, the covariance of the price of insurance and the other moments is assumed to be zero. This is consistent with the law of one price in this model of insurance.

The estimation program determines whether the candidate parameter vector leads to zero, one or two candidate equilibria. If it is zero or one, the estimation program has taken a "bad step." If it is two, then the estimation procedure finds the marginal agent for the stable equilibrium.

The moments are taken from the Medical Expenditure Panel Survey (MEPS) of 1999. Medical expenditure data from 1987 is available in the National Medical Expenditure Survey. However, there is no measure of medically-related bankruptcy for this year. The year 1999 is chosen because this is the only year of the 1990s where medical expenditure data and bankruptcy-survey data are available.

The MEPS provides nationally representative data on medical events such as visits to the emergency room or outpatient procedures. The data provide expenditure information for each event, including the amount and source of expenditure (e.g., private insurer, public insurer, or out-of-pocket (OOP)), and a breakdown of expenditures according to the goods or services provided. Data was collected for a nationally representative sample of households, and consists of the medical events of each member of a household.

The sample is restricted to non-Veterans under 65 years old, to avoid Medicare and VA distortions. Since the availability of Medicaid is also distortional, individuals in households rated as being below or very near the poverty line are also excluded. The data also contain information on the insurance status of individuals, which is used to find that approximately eighty percent of the individuals in the sample had private health insurance in 1999.

There is a difference between how much is charged for a medical event, and how much is eventually paid. These differ in part because of default. The charge variables are commonly described as being the "sticker price" of the medical event—in many instances, it is a starting point for negotiations rather than a final account of liability. Since households would face a "sticker price" after the medical services are provided, charges are used for estimation purposes.[4]

The cost of medical insurance is also provided by the MEPS. Single coverage of hospital and/or physician plan costs $2,324.76 on average.

The bankruptcy rate in the U.S. in 1999 was approximately 7.5 bankruptcies per one-thousand citizens between the age 18 and 65. As mentioned above, Jacoby et al. (2001) surveys bankrupt households and finds that about half of the bankrupt households in their survey cite medical reasons as the primary cause of their financial troubles. As a survey with limited response, the estimates of Jacoby et al. (2001) potentially suffer from response bias. For example, if wealthier bankrupt households were more likely to respond, then the causes of bankruptcy would be skewed towards those causes predominantly experienced by the wealthy. Unfortunately, the MEPS does not have any variables concerning the bankruptcy status of households. However, the MEPS reports both the expenditures and charges of each medical event, such as a visit to the doctor or emergency room.

Since the data do not report who was charged, default on the part of the individual must be inferred. EMTALA covers visits to emergency rooms and subsequent inpatient stays, so an EMTALA-related default must be associated with such an event. In order to count as a medical event where the household likely defaulted on the medical charges, a medical event must satisfy the following criteria:

- the ER visitor is uninsured; and
- the difference between expenditures and charges is at least $5000.

The MEPS asks medical service providers why charges differ from expenditures. Unfortunately, these answers are not provided in publicly available data.

Tables 1.2 and 1.3 present estimated parameters and data and model moments, respectively. The model fits the moments well. The overidentification statis-

[4]While insurers routinely pay less than amount charged, uninsured households are in a much weaker negotiating position.

tic, which is distributed $\chi^2(1)$ is less than four. The standard errors presented are calculated via bootstrapping, which is feasible because the estimation method is fast. Fewer than two percent of the one thousand bootstrap subsamples lacked observations with default .

Searching for stable equilibria also found the equilibrium that best fit the data moments. This procedure was set to solve for instable equilibria, and the fit was bad (i.e., large overidentification statistics). While this is not a result of the model, it is consistent with the intuitive appeal of the stability refinement.

1.3.1 Policy Experiments

An obvious question arises: what if we repealed EMTALA? Or, at the very least, made it costlier for the uninsured to default on medical bills? The qualitative answer is clear: the new stable equilibrium will have more agents choosing insurance, decreasing the cost of insurance and lowering the rate of medically-related bankruptcy.[5]

One way to make it costlier to default on medical debt would be to treat it differently in bankruptcy proceedings. The first policy experiment limits the ability of households to default on medical debt: make households liable for \$1400 worth of medical goods and services above and beyond standard bankruptcy costs.[6] The price of insurance is relatively inelastic, as it falls by just over \$100. However, the insurance rate increases by over six percent, and the default rate falls by two orders of magnitude. The second column of Table 1.4 reports the changes in the insurance rate, default rate and the price of insurance under this policy change.

Estimating the effects of fully repealing EMTALA is more complicated. Even if EMTALA were repealed, hospitals would still likely provide some free care for the

[5]The answers are opposite for an instable equilibrium. This runs contrary to the US experience after EMTALA. This, along with the fact that stable equilibria fit the data better, reinforce this choice of refinement.

[6]This corresponds to a twenty-five percent increase in the cost of default,κ.

uninsured facing large medical bills, as part of their not-for-profit mission. Because of this, the effects of repealing EMTALA as measured here are likely to be overestimates. The changes measured in this second experiment correspond to the repeal of EMTALA and the end of free care, both of which distort the demand for medical insurance. This counterfactual is calculated by setting κ to an arbitrarily large number. The third column of Table 1.4 presents the results of this policy experiment. The insurance rate increases to over 90%, while the cost of insurance falls to just over $2,000. The default rate is approximately zero.

It may be unlikely that the not-for-profit mission of hospitals could be overturned at the same time EMTALA is repealed. Because of this, I run a third experiment: set κ to $20,000. This limits an uninsured agent's liability in the event of onerous medical expense, while mitigating the potential effects of on insurance demand. Setting κ =$20,000 is a first-best guess at which point hospitals would provide charity care. The effects of this policy experiment are reported in the final column of Table 1.4. The effects are similar to those of the previous experiment.

If the cost of default decreases too much, then there may not be an equilibrium with insurance. The demand curve lies entirely below the supply curve if the cost of default falls much below $5000. This is a strong result, though its intuition is sound. Medical insurance is expensive. As it becomes easier to opt out of medical bills, an agent's willingness to pay for insurance decreases. If the provision of reduced-billing medical care becomes too widespread, then no one will pay for medical insurance.

1.3.2 What if EMTALA never happened?

This paper was originally motivated by the precipitous decline of medical insurance rates in the mid- to late-1980s. This section asks: What would have happened after 1986 had EMTALA not been passed?

As Cutler (2004) finds, medical technology has made great advancements in the past fifty years. For example, patients with heart attacks now receive more effective and expensive care than their counterparts in the 1950s. Because of this, it is unlikely that the distribution of medical risk, as characterized by α and β, remained constant through the 1980s and 1990s. In order to isolate the effects of EMTALA, these parameters must be estimated for the mid-1980s.

There is only one publicly-available data set that provides the cross-sectional distribution of medical charges for the mid-1980s. The National Medical Expenditure Survey collected such data for 1987. These data are used to find α_{1987} and β_{1987}, using the method of moments estimation described in Harris (1968). The cost of default for 1987, κ_{1987}, is set to match the insurance rate among the same population as above, and likely reflects the availability of free care for very rare and very expensive medical events.[7] Although 1987 is after the passage of EMTALA, it is unlikely the full effects of EMTALA were incurred until later. The estimate of κ_{1987} of over \$34,000 reflects this.

As mentioned before, there is reason to believe there were changes to the credit market beyond the scope of this model in the mid- to late-1990s. In order to isolate these changes from the effects of EMTALA, the final year of the experiment is 1996. The first wave of the MEPS was collected in 1996, and provides the information required to estimate the distribution of medical risk in 1996, i.e., α_{1996} and β_{1996}. The cost of default in 1996, κ_{1996}, is set to match the insurance rate among non-Veterans under the age of 65 whose household was above the poverty line. These parameters and moments can be found in Table 1.5. A linear trend provides the parameters of the risk distribution for the years between 1987 and 1996. Finally, the parameter of absolute risk aversion, r, is taken from the previous estimation from

[7] Because the NMES does not provide a variable stating whether a household is above or below the poverty line, all individuals whose households had wage earnings of less than \$8,000 were excluded. \$8,000 was chosen as it sits between the poverty lines for a families of two and three members.

the 1999 data.

Two trends of insurance rates are provided in Figure 1.12. The first, without EMTALA, finds the equilibrium insurance rate if the cost of defaulting on medical goods and services were held constant throughout the period. The second trend keeps κ_{1987} for 1987, and sets the cost of default to κ_{1996} for each subsequent year.

Had EMTALA not passed into law, the insurance rate would have *increased* from 1987 to 1996. The distribution of medical risk shifted in a way that would have led to less adverse selection and more risk sharing. These changes mask EMTALA's consequences as read from a simple plot of insurance rates over time, as in Figure 1.1.

1.4 Conclusion and Extensions

The number of consumer bankruptcies has grown dramatically since the mid-1980s. At the same time, the proportion of workers with medical insurance has fallen, while its price has grown. This paper ties both of these empirical phenomena to the 1986 passage of EMTALA. Had EMTALA not passed, the US insurance rate would have increased significantly after 1986, instead of the decrease that has been observed.

Among other parameters, this paper estimates the coefficient of absolute risk aversion. The estimation strategy depends upon the monotonicity of the insurance price schedule, $\varpi(\cdot)$, as it restricts the number and type of equilibria. Different preferences or distortional public insurance could lead to a non-monotonic price schedule.

Consider an economy where the agents have CRRA preferences. Agents are heterogenous in their risk like before. Most agents have wealth w_1, while a smaller number have $w_2 > w_1$. Figure 1.11 sketches out the price schedule in this environment. The non-monotonicity is caused by the wealthier agents whose willingness to pay for insurance is less than their counterpart with the same absolute risk but less wealth.

Before, stability was invoked to choose among equilibria, and it worked well because stable equilibria were unique. Figure 1.11 indicates two stable equilibria exist. Adding more features to the model, such as the availability of public insurance, might also add more stable equilibria.

Estimation programs need to know which of the candidate stable equilibria to choose. The equilibria are Pareto ordered, with more insurance Pareto preferred to less. This is consistent with the literature of macroeconomic complementarities, as discussed in Cooper (1999). It provides a first-principles rationale for choosing among equilibria.

That said, it is not clear that the medical insurance market is Pareto optimal. Recent legislative action has attempted to shift away from the current equilibrium. The most well known of these initiatives was passed in Massachusetts, where taxing un-insurance was designed to increase the number of citizens with insurance and decrease its cost. Was this an attempt to make a Pareto-improving shift, or was it just the insured median voter attempting to decrease the cost of his or her insurance?

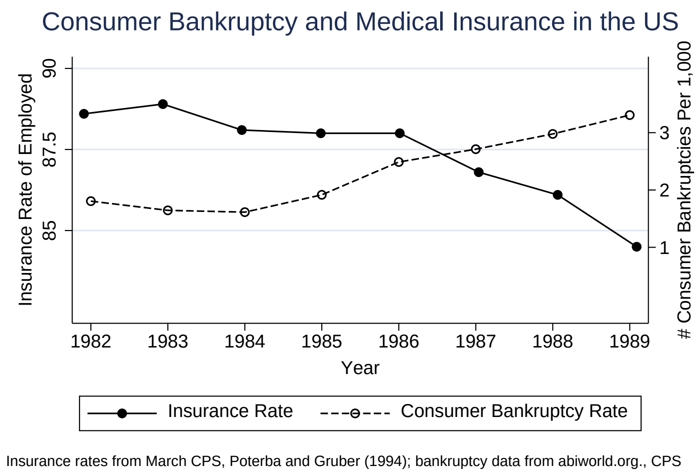


Figure 1.1: Consumer Bankruptcy and Insurance

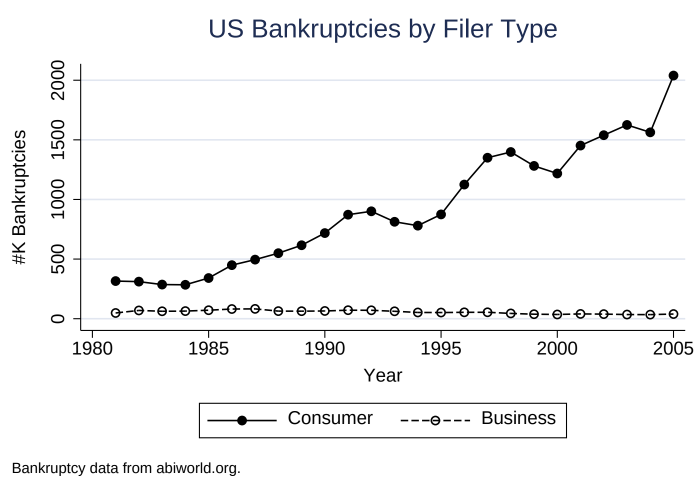


Figure 1.2: Bankruptcy in the US

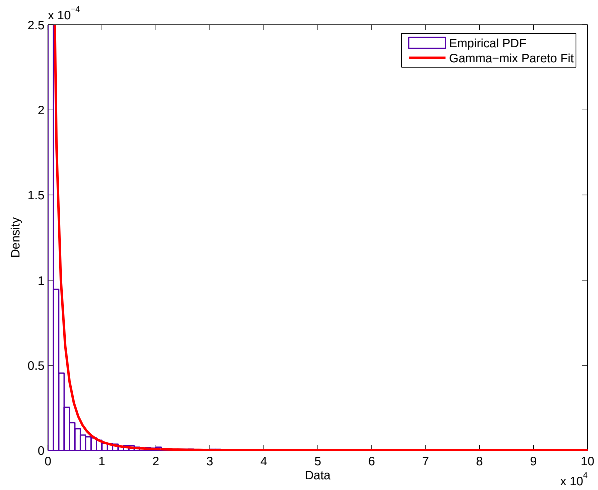


Figure 1.3: Empirical PDF of Charges and a Gamma-mix Pareto fit

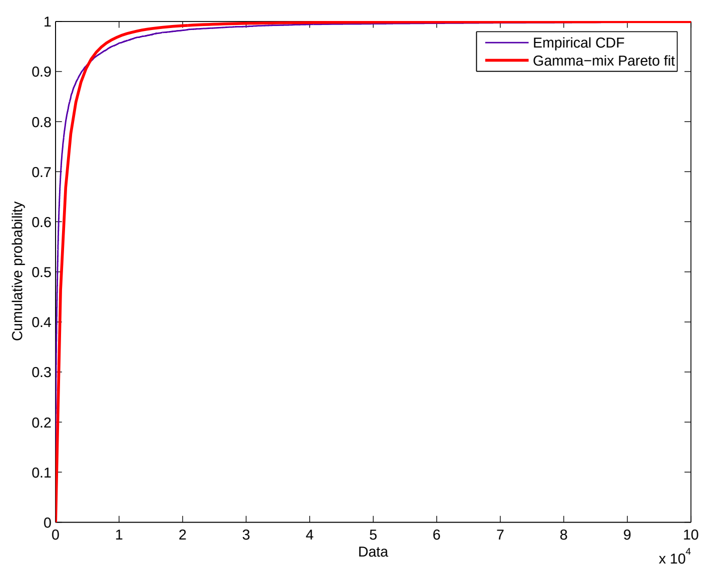
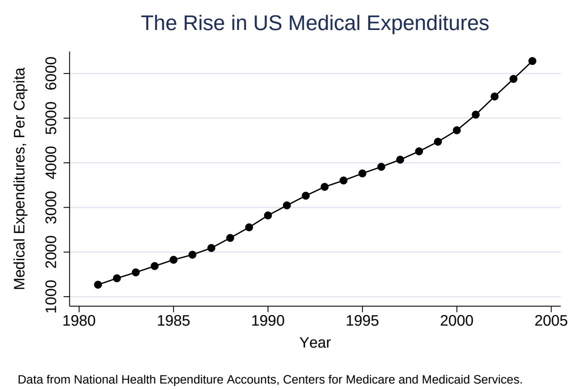
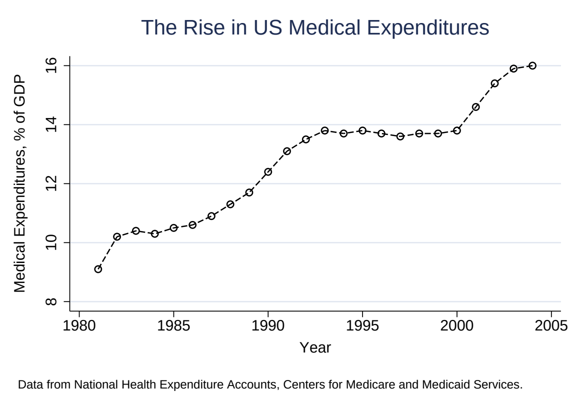


Figure 1.4: Empirical CDF of charges and a Gamma-mix Pareto fit

Figure 1.5: Medical Expenditures in the U.S.



(a)



(b)

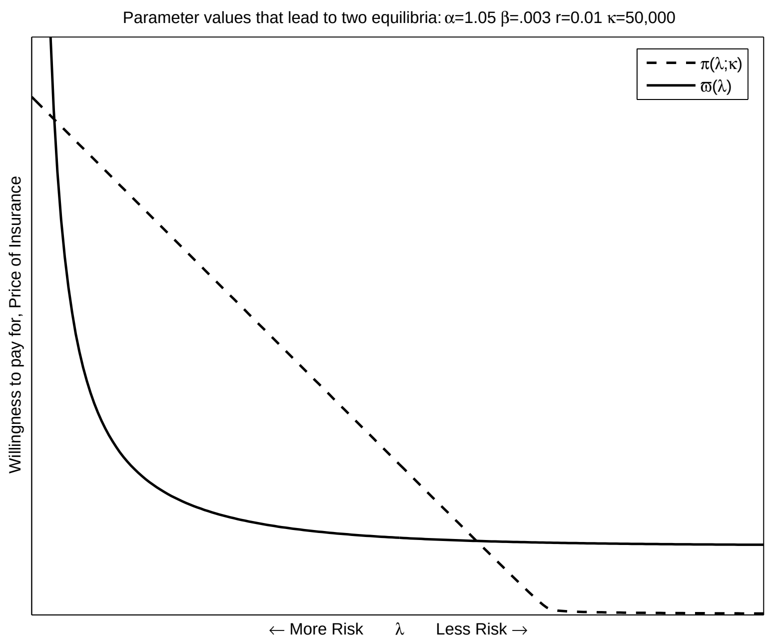


Figure 1.6: Two equilibria.

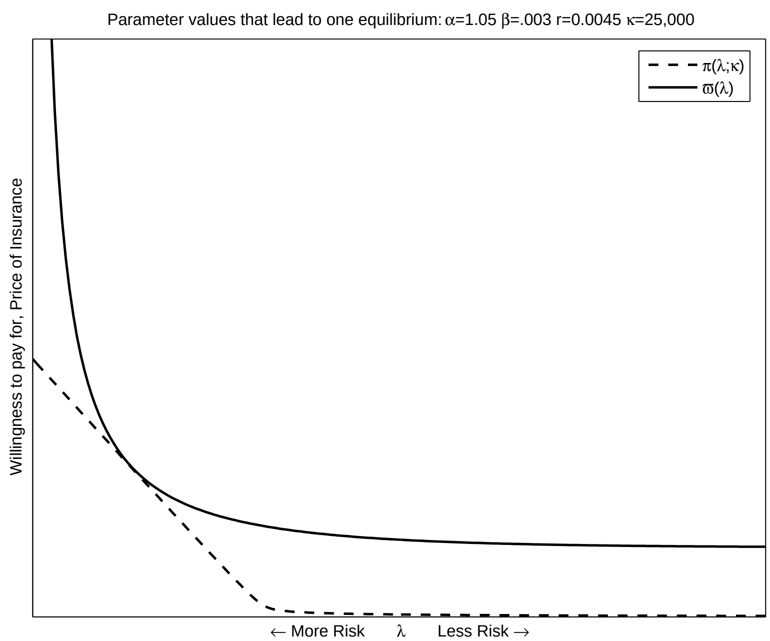


Figure 1.7: One equilibrium.

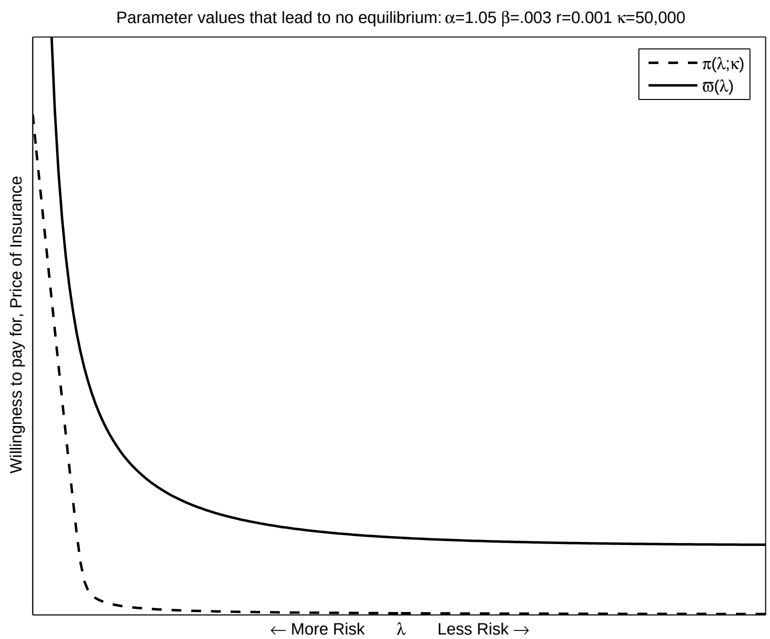


Figure 1.8: No equilibria.

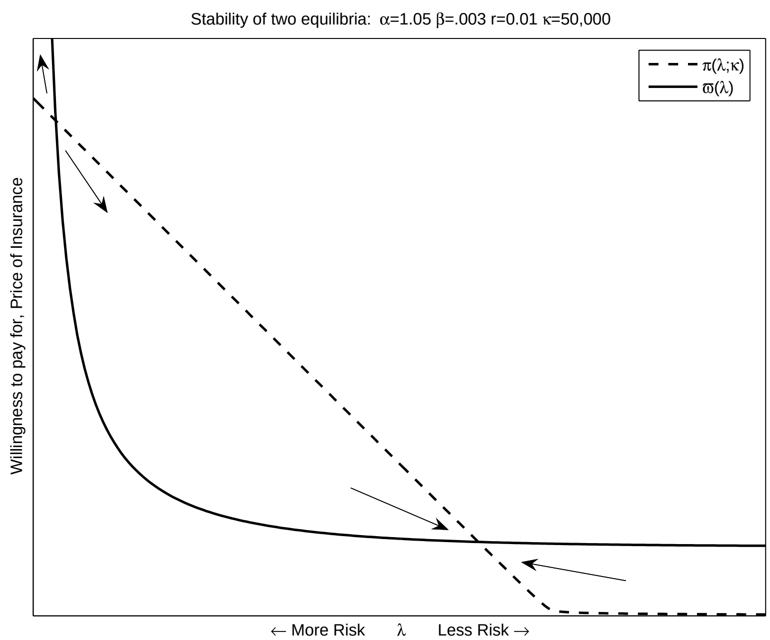


Figure 1.9: The equilibrium with a lower insurance rate is not stable, while the equilibrium with the higher insurance rate is stable.

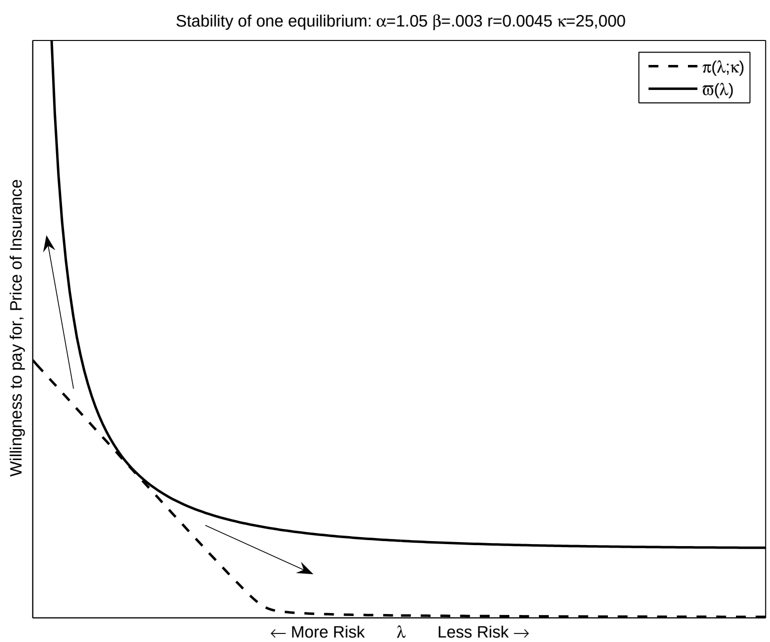


Figure 1.10: The single equilibrium for these parameter values is not stable—it will not withstand the marginal agent deviating from equilibrium behavior.

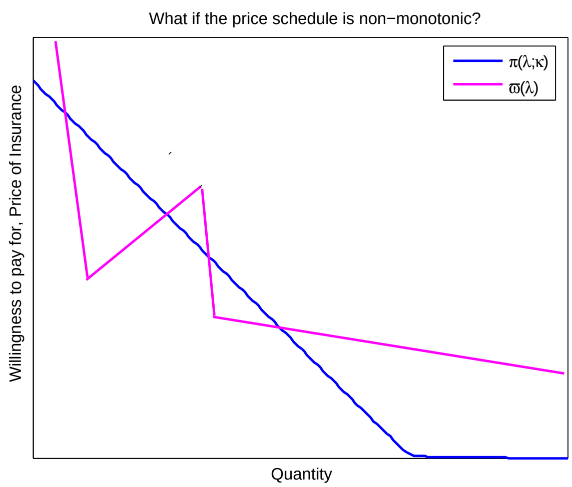


Figure 1.11: A non-monotonic price schedule can lead to multiple stable equilibria, which complicates estimation.

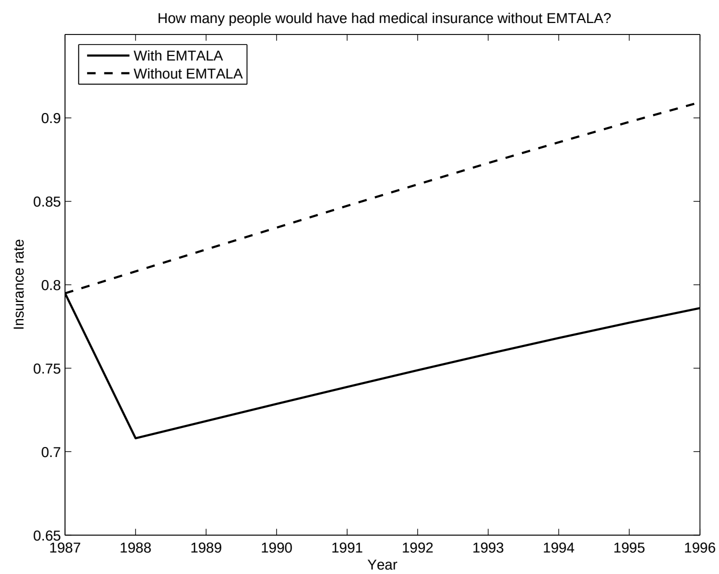


Figure 1.12: A plot of the insurance rate during the late 1980s and early 1990s with and without EMTALA. The estimation procedure for this graph is described in the text.

Table 1.1: Insurance Rates Among the Employed Before and After EMTALA, by Income

Income	1985-6	1988-9	Δ
0-5K	36.0	30.9	-5.1
5-10K	51.7	45.5	-6.2
10-20K	80.0	74.3	-6.7
20-30K	92.4	88.9	-3.5
30-50K	96.5	95.2	-1.3
50K+	97.9	97.4	-0.5
All	87.9	84.9	-3.0

As reported in Gruber and Poterba (1994a).

Table 1.2: Estimated Parameters (SEs) Using Percent Deviation from Moments

α	β	r	κ
1.1263	4.5809×10^{-4}	0.002	5,668.8
(0.0156)	(6.91×10^{-6})	(3.16×10^{-5})	(150.85)

Table 1.3: Model Moments from Estimated Parameters in Table 1.2

Moment	Data	Fit
$\bar{\iota}$	0.784	0.7839
ϖ	2,324.76	2,324
$\overline{d}$	1.803×10^{-4}	1.72×10^{-5}
$\overline{mx}$	1984.93	1,938
σ_{mx}	8392.79	7957.39
	$\chi^2 = 3.8745$	

Table 1.4: Model Moments of Experiments %

Moment	Fit	Experiment 1	Experiment 2	Experiment 3
$\bar{\iota}$	0.7839	0.8481	0.9178	0.9178
ϖ	2,324.8	2,199.5	2.0751	2,075.1
$\overline{d}$	1.72×10^{-5}	1.1085×10^{-7}	0	0
$\overline{mx}$	1,938	1,938	1,938	1,938
σ_{mx}	7957.39	7957.39	7957.39	7957.39

Experiment 1 gives preferential treatment to medical debtors. It corresponds to setting $\kappa = 7085$. Experiment 2 repeals EMTALA and ignores the availability of free care for the uninsured with large medical bills. The corresponds to κ equal to the largest real number Matlab can manage: 1.7977×10^{308}. The third and final experiment repeals EMTALA, but allows for some free care for the uninsured when the medical bill is greater than $20,000.

Table 1.5: The estimated parameters and moments for the years of interest of the final policy experiment.

	1987	1996
α_{year}	1.10988	1.0797
β_{year}	6.7×10^{-4}	5.633×10^{-4}
$\bar{\iota}_{year}$	.7949	.786
κ_{year}	34,843	7,085.8

κ_{year} was set to match the insurance rate of that year, $\bar{\iota}_{year}$. The NMES (1987) and MEPS (1996) were used to find α_{year} and β_{year}.

Chapter 2

How Much for Your Medical Insurance? Using the Theory of Equalizing Differences:

In the United States private medical insurance is an amenity that many jobs offer. Since private medical insurance is a costly and desirable amenity, a worker should receive higher wages if private medical insurance is not part of a job's benefit package. This difference in wages is the compensating differential—how much more money in wages does the worker receive if the firm does not provide private medical insurance.

Marginal income taxes distort the choice between benefits and wages. Firms' contributions for private medical insurance are tax-exempt. If a worker went without these benefits, then the compensating differential would be subject to income taxes. This drives a tax wedge between wage income and insurance, leading to "overinsurance."

Increasing marginal tax rates increases the size of this tax wedge, increasing the number of workers with insurance. The relationship between marginal tax rates and the number of jobs without private medical insurance can be expressed as an elasticity. If this "market elasticity" is large, then a small change in the tax code would have a large effect on the number of Americans privately insured through their jobs.

This market elasticity should be contrasted with what has typically been estimated in the previous literature. Studies such as Gruber and Poterba (1994b) have focused on the price elasticity of individuals—i.e., how does the probability of having medical insurance adjust as the marginal tax rate changes. These studies use discrete choice models with latent equations determining the probability of having insurance. However, the price elasticity of individuals is not sufficient to calculate the market elasticity. Were these papers to attempt to convert the price elasticity ("how do probabilities change") into a market elasticity ("how many people actually switch"), the methods would likely depend upon the fitted values of the latent equation.

Doing this has two main flaws. The fitted values of the latent equation have no economic meaning; they are just econometric conveniences. Moreover, these fitted values are consistent only if all the estimates of the latent equation are themselves consistent. Typical explanatory variables in the latent equation are age, gender and family size. Medical information is usually omitted from the latent equation. It is unlikely that these fitted values are actually consistent.

I avoid these pitfalls by estimating the demand curve for private medical insurance, and use that to estimate the market elasticity, and the potential effects of large tax changes. Private medical insurance covers the uncertain nature of medical expenditures. Following Pratt (1964), a household's willingness to pay for insurance is a combination of the amount it expects to spend for medical goods and services, and the variance of the medical expenditure risk. The distribution of willingness to pay constitutes the demand curve for private medical insurance.

It is also worthwhile to contrast this approach with Olson (2002). Like many previous studies of compensating differentials, Olson (2002) attempts to measure the compensating differential for private medical insurance. Olson's (2002) estimated compensating differentials are consistent with those found in this study. However, Olson (2002) estimates are not sufficient to find the market elasticity, much as determining the price of an apple does not tell us how many apples would be bought and eaten if the price of apples doubled.

The Medical Expenditure Panel Survey (MEPS) is used to estimate the demand curve for private medical insurance. The MEPS provides a rich collection of information on an entire household's medical expenditures and their source, such as private medical insurance. Variety in medical expenditure risk faced by households leads to variety in willingness to pay for private medical insurance.

In the main sample from 2002, approximately one-quarter of the jobs do not include private medical insurance as part of the compensation package. The market elasticity is found to be between one and two—that is, if firms are taxed one cent for every dollar spent on private medical insurance for its employees, then the proportion of jobs without private medical insurance will increase between one and two percent. If firms are taxed at the worker's marginal tax rate (Federal income tax plus FICA), then approximately 35 percent of the jobs would be without private medical insurance.

The balance of the chapter is as follows: first, a theoretical model is posited, to explain the relationship between a household's insurance choice, tax policy and the compensating differential; an estimation strategy for the demand curve for private medical insurance; measurements of the market elasticity and the effects of a changes of tax policy; and a conclusion.

2.1 Theoretical Model

This section constructs a theoretical model designed to be consistent with many of the real-world features of a household's private medical insurance choice:

- households value private medical insurance according to their medical expenditure risk;
- the cost of private medical insurance is not taxed, while wage income is, per the US tax code;
- and workers are paid less for jobs with private medical insurance, *ceteris paribus.*

Consider a one period model, with workers, firms, and insurers. There are two markets: the market for labor and the market for insurance. Both markets are efficient, so a worker's total compensation equals his or her marginal product; and the cost of insurance is equal to its cost of production.

2.1.1 The Workers' Problem

Workers are risk averse and face risk in medical expenditures. They are heterogenous in this risk: worker i faces risk $\widetilde{mx}_i$. Workers are also heterogenous in productivity, with worker i's productivity given by w_i. Medical expenditures are consumed inelastically, so are treated as a loss in income.

Workers face a wage tax. The tax schedule may have kinks, so the average rate ϕ_i^a, and the marginal rate ϕ_i^m may differ for an individual, and vary across individuals. It is important to note that this tax is on wages only. This tax pays for a public good, G, which all workers enjoy.

Workers can purchase private medical insurance directly from an insurer, or obtain it as part of their compensation package from a firm. If the worker purchases private medical insurance from the insurer, the price is p^s_{ins}. If the worker does not want insurance as part of the compensation package, then the after-tax wage without medical insurance is $(1-\phi^a_i)\omega^{ins=0}_i$; if insurance is included, then the after-tax wage is $(1-\phi^m_i)\omega^{ins=1}_i$. The before-tax difference, $\omega^{ins=0}_i - \omega^{ins=1}_i$, is the compensating differential of private medical insurance. If the worker chooses insurance, the worker acquires it from the low-price provider: either through the firm, or directly from the insurer.

Workers face the maximization problem:

$$\begin{aligned} \max\{ \quad & E[U((1-\phi^a_i)\omega^{ins=0}_i - \widetilde{mx}_i, G)], \\ & U((1-\phi^a_i)\omega^{ins=1}_i, G), \\ & U((1-\phi^a_i)\omega^{ins=0}_i - p^{ins}_i, G)\}. \end{aligned} \tag{2.1}$$

with $U(c,G) = u(c) + v(G)$, with consumption c and level of public good supplied by the taxation of wages, G. The first term is the expected utility if the worker does not have private medical insurance. The second term is the expected utility if the worker has insurance through the employer, while the third term is the utility if the worker buys insurance directly from the insurer.

If preferences display constant relative risk aversion (CRRA) in consumption, a worker's willingness to pay for private medical insurance is a fraction $\widehat{\pi}(\tilde{z}_i)$ of his or her wage such that:

$$E[U((1-\phi^a_i)\omega^{ins=0}_i - \widetilde{mx}_i, G)] = U((1-\phi^a_i)\omega^{ins=0}_i - \widehat{\pi}(\tilde{z}_i)\omega^{ins=0}_i, G)$$

As Pratt (1964) shows, this proportion is a function of the expectation and variance of worker's risk:

$$\widehat{\pi}(\tilde{z}_i) = \frac{1}{2} r\sigma^2_{z_i} + E(\tilde{z}_i),$$

where r is the worker's coefficient of relative risk aversion; $E(\tilde{z}_i) = E(\frac{\widetilde{mx}_i}{(1-\phi_i^a)\omega_i^{ins=0}})$ is the expected value of the risk, proportional to the worker's income; and $\sigma_{z_i}^2 = \frac{\sigma_{mx_i}^2}{((1-\phi_i^a)\omega_i^{ins=0})^2}$ is the variance of the risk, made proportional to the worker's income.

Previously in the literature, $\widehat{\pi}(\tilde{z}_i)$ has been referred to as the marginal willingness to pay for medical insurance. Since this willingness to pay is a function of risk aversion, I will refer to it as the insurance premium. This should not be confused with the use of "premium" as seen as deductions on paychecks. This terminology unfortunately conflates the value of insurance (the usage of economists), and its price (what human resources departments list).

Workers choose whether to include insurance as part of a job's compensation package according to the inequality of Equation (2.2). The worker's problem can now be reduced to:

$$\widehat{\pi}(\tilde{z}_i)\omega_i^{ins=0} \gtreqless \min\{(1-\phi_i^m)(\omega_i^{ins=0} - \omega_i^{ins=1}), p_i^{ins}\} \tag{2.2}$$

Note that the price of insurance from the firm is the after-tax compensating differential. If $\widehat{\pi}(\tilde{z}_i)\omega_i^{ins=0} \geq (1-\phi_i^m)(\omega_i^{ins=0} - \omega_i^{ins=1}) > p_i^{ins}$, then the worker buys private medical insurance directly from the insurer. If $\widehat{\pi}(\tilde{z}_i)\omega_i^{ins=0} \geq p_i^{ins} > (1-\phi_i^m)(\omega_i^{ins=0} - \omega_i^{ins=1})$, then the worker gets private medical insurance from his or her employer. If $\widehat{\pi}(\tilde{z}_i)\omega_i < \min\{(1-\phi_i^m)(\omega_i^{ins=0} - \omega_i^{ins=1}), p_i^{ins}\}$, then the worker forgoes medical insurance altogether.

2.1.2 The Production of Insurance and Equilibrium Behavior

The production of private insurance costs insurers a constant proportion ϖ of the productivity of the worker. The private medical insurance market is competitive, so the market price of private medical insurance is equal to its cost of production, $p_{ins}^s = \varpi w_i$. The insurers can sell insurance to either workers or firms.

The firm's production technology has only one input, labor, and its output is the sum of the marginal productivity of its workers. Since the labor market is competitive, the total compensation of a worker is equal to that worker's productivity, w_i. If the worker does not want private medical insurance to be included as part of the compensation package, then the worker is paid $\omega_i^{ins=0} = w_i$. If the worker does want private medical insurance to be provided by the firm, then the wage reflects the cost of insurance to the firm: $\omega_i^{ins=1} = (1 - \varpi)w_i$. Thus, the compensating differential is a proportion ϖ of a worker's productivity.

The tax schedule is taken as exogenous. Tax revenue is used to purchase public good G. While the use of tax revenue has important welfare implications, such welfare questions are beyond the scope of this chapter.

The taxation of wage income leads to an important aspect of this model. If $\phi_i^m > 0$, workers prefer to include private medical insurance as part of their job's benefit package, rather than buy it from the insurer directly. If the worker were to buy insurance directly from the insurer, then wage taxes would be due on the income used to pay for the insurance. If insurance is provided by the employer, this extra wage tax is circumvented.

Because of the potential heterogeneity in marginal tax rates, it is convenient to adjust the insurance premia for marginal tax rates: $\pi(\tilde{z}_i) = \frac{\widehat{\pi}(\tilde{z}_i)}{(1-\phi_i^m)}$. The inequality which governs the choice of private medical insurance, Equation (2.2), can now be re-written:

$$\pi(\tilde{z}_i) \gtrless \varpi.$$

2.1.3 Finding the Market Elasticity

Suppose that the heterogeneity in $\pi(\tilde{z}_i)$ is described by the PDF in Figure 2.1. The vertical line marks where $\pi(\tilde{z}_i) = \varpi$—i.e., where the worker's insurance premium $\pi(\tilde{z}_i)$ is equal to its price ϖ. The mass of workers to the right of this line will choose private medical insurance, while those workers to the left will forgo it.

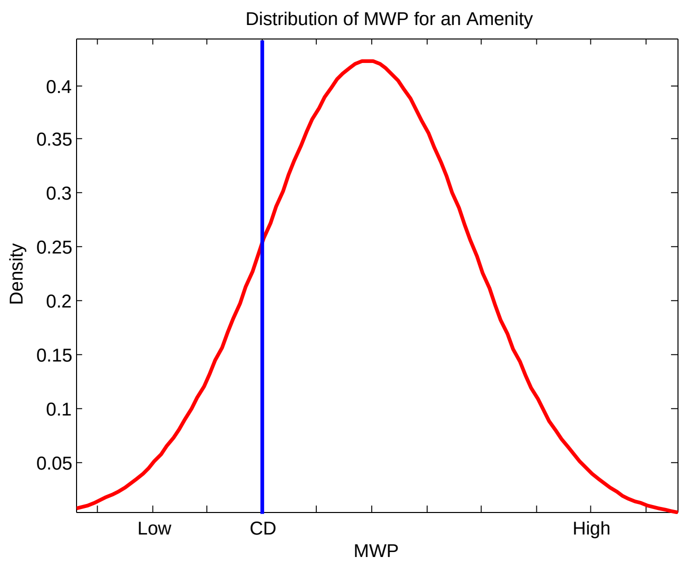


Figure 2.1: A Hypothetical Distribution of Insurance Premia

Suppose the cost of producing private medical insurance increases: ϖ increases. The vertical line in Figure 2.1 shifts to the right, without affecting the distribution of $\pi(\tilde{z}_i)$. More employees would decline private medical insurance.

The number of workers without private medical insurance changes with the compensating differential according to $\frac{\partial D(\varpi)}{\partial \varpi} = d(\varpi)$. Converting this into an elasticity yields the market elasticity:

$$\epsilon = \varpi(\frac{d(\varpi)}{D(\varpi)}), \tag{2.3}$$

where d is the PDF of $\pi(\tilde{z}_i)$'s, and D is the CDF $\pi(\tilde{z}_i)$'s.

The compensating differential is the firms' marginal cost of providing private medical insurance; so taxing firms' private medical insurance cost increases the compensating differential. Taxing firms τ times the cost of providing private medical insurance increases the compensating differential to $(1+\tau)\varpi$. The worker receives an $(1-\phi_i^m)(1+\tau)\varpi$ increase in after-tax wages if private medical insurance is forgone.

Taxing the households does not change firms' marginal cost of private medical insurance production. However, it does change the value of private medical insurance to workers. If the household is taxed τ times the cost of the private medical insurance it receives, then the value of private medical insurance to worker i is $\widehat{\pi}(\tilde{z}_i) - \tau\varpi$. Worker i's after-tax proportional insurance premium is $\widehat{\pi}(\tilde{z}_i) - \tau\varpi$, and the distribution of values is shifted to the left. If the worker forgoes medical insurance, then he or she receives the compensating differential less the marginal wage tax, $(1-\phi_i^m)\varpi$.

This leads to an important result: fewer workers will have medical insurance if the worker is taxed for having medical insurance than if firms' expenditure on medical insurance is taxed. In this theoretical model, private medical insurance is subsidized through the compensating differential at rate $\phi_i^m\varpi$. This subsidy comes from the non-taxation of private medical insurance. Taxing firms' expenditures on medical insurance increases this subsidy by $\phi_i^m\tau\varpi$. If the worker is taxed for having private medical insurance, then the compensating differential is not changed; thus, the subsidy does not change. In both cases, though, the tax increases the cost of having private medical insurance at the same rate, $\tau\varpi$. However, taxing the firm increases the subsidy to private medical insurance via the compensating differential.

The focus of this chapter is: how many more jobs would be without medical insurance if the cost of medical insurance were taxed as income. The balance of this chapter is focused on estimating distribution of $\pi(\tilde{z}_i)$. From this, the sensitivity of the number of jobs without medical insurance to a shift in taxes can be found. Since the number of jobs in the sample with medical insurance is known, the distribution will imply a compensating differential. If the static model and degree of risk aversion are correct, then the implied compensating differential should be similar to previous estimates.

2.2 The Data and Econometric Models

The data are from Panels Six and Seven of the Medical Expenditure Panel Survey (MEPS), with information from 2002. The MEPS provides a rich set of data on medical insurance, medical expenditures, and their sources, for individuals. Entire households are interviewed, so the intra-household aspects of medical insurance decisions can be observed. When a member of the household is employed, information on that job, such as occupation, wage, benefits, hours, and firm size and industry, is collected. The medical expenditures are broken down into sources, such as private medical insurance, public medical insurance (e.g., Medicare and Medicaid), and out-of-pocket.

For the purpose of this research, and for comparability to previous work, the insurance variable of interest is whether or not private medical insurance is part of the current job's benefit package. Data on medical insurance acquired through COBRA (for individuals who lose or leave their jobs), or supplemental Medicare insurance, are beyond the focus here.

The household's average and marginal federal income tax rate and marginal FICA rate are computed using NBER's TAXSIM. The MEPS provides several variables, such as dependent identifiers, tax filing information, and non-wage property income, that allow for a detailed calculation of worker's federal tax profile (i.e., ϕ_i^a and ϕ_i^m).

The estimation of medical expenditure risk is based on medical condition information. This information is also provided by the MEPS. Conditions are coded according to the International Classification of Diseases (ICD-9) system. This coding system is particularly useful to economists, as it classifies conditions according to the medical specialty that provides treatment, which in large part determines the cost of treatment.

This information was used to construct condition dummy variables for individuals with the following conditions: essential hypertension, lipid disorders (high cholesterol), pregnancy, diabetes, cancer (excluding skin), psychological disorders (depression and anxiety), allergies, sinusitis and other. These conditions were either identified by the ICD-9 code, or an aggregation of ICD-9 codes provided by the MEPS. The vector of condition dummy variables will be referred to as the individual's condition profile.

Since the condition profile is the primary determinant of medical expenditure, an individual's knowledge of his or her condition profile is key to estimating the expectation and variance of medical expenditure risk. Two extreme cases are considered: in the first, the condition profile is known to the individual. In the second case, the probability of having a condition is forecast from a set of medically relevant demographic variables.

The first case is provided as lower bound for the insurance premia values, since no one knows with perfect certainty what conditions will be realized. The second case is an upper bound; much of the relevant information determining the true probability, such as family history, is known to the individual but not the econometrician. The estimated variance of the forecast will be larger than the true variance of the forecast. Since many of the conditions under consideration are either chronic (e.g., hypertension, diabetes, high cholesterol), or otherwise frequently known to the individual (pregnancy), the first case should be a more reasonable approximation of true insurance premia.

The strong relationship between medical conditions and medical expenditures also undermines any attempt to estimate the risk $\tilde{z}_i$ without medical condition information. If the estimation of risk $\tilde{z}_i$ were undertaken with demographic information only, and the condition profile omitted, the strong correlation between many of these conditions and the demographic variables such as age and gender would lead to biased estimates.

The medical expenditures reported in the data are annual. In order to focus on the dollar value of medical goods and services private medical insurance would be expected to provide, expenditures paid for an insured individual by private medical insurance are used. These annual variables are divided by the number of months the individual is insured, to make them comparable to the monthly wage data.

Since going to the doctor is less expensive for the insured, it may be the case that the insured are diagnosed more often, *ceteris paribus*. To correct for this, Heckit estimation is used to find the expectation and variance of an individual's medical expenditures paid for by private medical insurance. The two estimated equations are:

$$\begin{aligned} mx_i &= C_i\beta + u_1 \\ I_i &= 1(C_i\gamma_1 + F_i\gamma_2 + u_2 > 0), \end{aligned}$$

where mx_i is observed if $I_i == 1$ (insurance is observed), and F_i is information that affects the likelihood of being insured, but not the medical expenditure of the individual. Information on the condition profiles of the other household members is used to identify the second equation. By assumption, u_1 is uncorrelated within a household, and the insurance decision is made on the household level. The larger the expected expenditures within the household beyond the individual in question, *ceteris paribus*, the more likely the worker will include health insurance as part of the benefit package.

The selection equation should not be confused with the inequality in Equation (2.2), which determines the medical insurance choice. The regression equation describes the level of medical expenditure, not its proportion of wages. Further, insurance decisions are made at the household level, and such information is not included except as instruments.

Since u_1 is uncorrelated within a household by assumption, the total expected value and variance for a household is the sum of the household members' expected values and variances. The sum of the fitted values is divided by the after-tax monthly wage, and sum of the variances of the fitted values is divided by the square of the after-tax monthly wage, to convert them into the expectation and variance of a proportional risk.

In the first case, the condition profiles are used as explanatory variables in the expenditure equation. Due to the limitations of the data, these indicate whether the medical condition occurred at some point during the year, but not for how many weeks that treatment was received. Some of these conditions have a variety of medical services that could be used for treatment. For example, one person's diabetes may be more severe than another's, requiring more costly services. The variance of the regression equation comes from two sources: uncertainty in the severity and duration of the condition.

In the second case, the explanatory variables are the condition profile forecast. The variables are split into three groups: Demographic information X, which is a collection of known things, such as age, gender, body-mass index (BMI), whether the individual smokes, race, and Hispanic ethnicity; the condition profile, C, is not known to the individual, but the individual can use the known demographics to inform a consistent estimate of $\widehat{C}$; and mx_i, which is the expenditure by private medical insurance in treating the realized conditions. The estimation procedure has the following order:

$$X_i \rightarrow \widehat{C_i} \rightarrow \widehat{mx_i}.$$

This is not unlike Woodridge's (2002) Procedure 17.2, which is a Heckit estimation with endogenous regressors. Procedure 17.2 can be translated into the three equations:

$$C_i = X_i\gamma + u_3 \tag{2.4}$$

$$mx_i = C_i\beta + u_4 \tag{2.5}$$

$$HI_i = 1(C_i\delta + u_5 > 0) \tag{2.6}$$

where mx_i is observed if $HI_i == 1$.

Equation (2.4) estimates the probability an individual will have some vector of conditions. Someone who is more likely to have hypertension than the demographics would otherwise suggest should also be otherwise more likely to suffer from a lipid disorder. That is, errors are likely to be correlated across equations. To account for this, the sub-equations of Equation (2.4) are estimated using a standard seemingly-unrelated regression techniques in a linear probability model.

The Heckit estimation uses the fitted probabilities to estimate the medical expenditures equation. The variance-covariance matrix of Equation (2.5) is Ω. Per Feldstein (1971), the variance of the forecast is:

$$\sigma^2_{mx_i} = \widehat{C}'\Omega\widehat{C} + \beta'\Phi\beta + trace(\Phi\Omega) + \sigma^2_{u^2}. \tag{2.7}$$

The first and last term are what is traditionally known as the variance of the fitted value, while the middle two terms arise from the estimation variance of $\widehat{C}$. It should be noted that Feldstein's (1971) calculation requires that u_3 is uncorrelated with (u_4, u_5). If this does not hold, then the two-step estimation is not efficient. This would lead to overestimation of $\sigma^2_{mx_i}$, and reinforce the overestimation of $\pi(\widetilde{mx}_i)$. It also omits added variance from interacting the forecast and the selection equation. However, since the estimated selection effects are weak, this omission is unlikely to be large.

The demographic variables are excluded from the expenditure equation. This approach makes a strong, though sensible, identification assumption. Expenditures are influenced by demographic information only insofar as they make an individual more likely to suffer from a condition. Older individuals, for example, have more expenditures not by the very fact that they are old. Rather, aging is positively associated with any number of costly conditions.

The estimates of Equation (2.4), using a seemingly-unrelated linear probabilities model, are presented in Table 2.2. Most conditions are positively associated with age and BMI. Second-order terms and interactions with gender are provided, since, for example, pre-menopausal women infrequently suffer from lipid disorders. The estimated variance-covariance matrix of the SUR is provided in Table 2.3. The off-diagonal elements (cross-equation variance) are as high as one-third of the respective on-diagonal elements (within-equation variance). The signs of the off-diagonal variances are intuitive, with a positive covariance for the errors in the hypertension, lipid disorder, and diabetes equations.

In both cases, the estimation used a sample of individuals over the age of sixteen. For children sixteen and younger, the average and variance of expenditures were used for the expectation and variance of expenditures, respectively. It is unusual to observe many of these conditions in persons under the age of seventeen. In the second case, the demographics used for adults, such as BMI and smoking, are not comparable for youths. Also, veterans are removed because their expenditures on medical goods and services paid for by private insurance will be skewed by the availability of VA benefits.

These procedures will produce distributions of $\pi(\tilde{z}_i)$, which imply the compensating differential ϖ. However, before the distribution is computed, the wages for jobs with medical insurance must be increased by $(1-\phi_i^m)\varpi$, the after-tax compensating differential. This is resolved by starting with an educated initial guess, ϖ_0, and updating that guess with the implied compensating differential, ϖ_1. This process is iterated until $\varpi_n \approx \varpi_{n+1}$.

2.2.1 Estimation Results

When the condition profile is known to the individual, the expenditure equation estimates are sensible. These estimates are provided in Table 2.1. The units of the estimates are weekly expenditures. Cancer ($60 per week) is more expensive than sinusitis and allergies, for example. The demographic variables, age, gender and their interactions are not statistically significant. This should come as no surprise, since medical expenditures are primarily a result of medical conditions. While we may intuit older individuals consuming more medical goods and services such as office visits, this effect pales in comparison to the increase in expenditures when a person of any age becomes diabetic, or suffers from depression or anxiety.

The estimate of λ, which measures the degree to which selection impacts the medical expenditure equation, is not statistically significant from zero. That is, individuals with private medical insurance do not spend more for medical services than those without, *ceteris paribus*. For example, when the marginal effects are estimated, the expenditure equation's effects dominate. This suggests that the diagnosis of conditions is independent of having private medical insurance. The estimation of Equation (2.4) is provided in Table 2.2.

Since family history of these conditions is an omitted variable in this estimation, omitted variable bias is a concern for the BMI estimates. For example, an individual might attempt to lose weight when his or her father contracts hypertension. However, many of these conditions are late onset, so a family history for a condition may not become established until the parents are in their 50s or 60s. This means that the persons themselves will not learn of their own family history until their 30s or 40s. At these ages, weight-loss is complicated by lower metabolism and the difficulty of changing lifestyle habits, such as diet and (lack of) exercise.

The estimated variance-covariance matrix of the SUR is provided in Table 2.3. Its off-diagonal elements suggest that, for example, someone who has hypertension in spite of a low predicted probability of having hypertension is also likely to have diabetes in spite of a low predicted probability of having diabetes. Many of these cross-equation variances are more than a tenth of the own-equation variances, some as high as a third. This suggests that the condition probability equations should not be estimated independently.

The estimates of Equations (2.5) and (2.6) can be found in Table 2.4. The standard errors of the estimation are large, and this is by design. Large standard errors lead to a large amount of uncertainty if the individual goes uninsured. The estimates themselves are less satisfactory, with increased probability of some conditions associated with decreased expected expenditure. However, this does not lead to negative forecasted values of medical expenditure. For cancer and diabetes, the estimates are positive.

The second and third terms of Equation (2.7) are the added variances due to the uncertainty of forecasting the condition profile. This additional variance is, on average, one and a half times the variance of the first and fourth terms. That is, the variance due to the uncertainty in forecasting (the terms with Φ) is a large component of the overall variance.

2.3 The Distribution of Insurance Premia

With these measures of a household's medical expenditure risk, we have an estimated demand curve for private medical insurance. We can now use this distribution to estimate the market elasticity of marginal tax rates and the effects of large tax changes.

As mentioned above, TAXSIM provided the average and marginal Federal income and FICA tax rates. They were calculated using a projected annual wage income (weekly earnings times fifty-two); variables on filing status and old and young dependents were used in the calculation. Other non-wage property income is available in the data, but were not used in the TAXSIM calculations. They were not used, in part, because the MEPS documentation warns that such variables are not edited for consistency. Due to privacy restrictions, state residency status is not known, so state income taxes are not calculated.

Marginal tax rates are very important in determining the value of medical insurance to a worker. Marginal Federal income tax rates can be as large as 41% in the sample, while FICA marginal tax rates are typically 15%. For some individuals, this means that only one half of the compensating differential would actually be received.

The theoretical model emphasized that households are collectively making medical insurance decisions. After the first medical insurance plan, a second plan has no value in a static setting. The theory provides no immediate intuition on choosing to whom to assign the value of insurance among multiple wage-earners in a household.

Three criteria could be used as a proxy for this assignment. The first chooses the worker in the household with the lowest wage. Suppose the two workers in a household earn wages w_h and w_l, where $w_h > w_l$. If all medical insurance plans are perfectly substitutable, then a household would choose insurance from the low-wage job, since it costs less: $\varpi w_l < \varpi w_h$. This is not entirely satisfying, since it may be assigning the value of medical insurance to workers only marginally attached to the labor force. (I.e., the opportunity cost of leaving the job, the total compensation of the job, is higher for the household member with the higher wage.)

A second criterium chooses the worker in the household with the highest wages. If there are differences among medical insurance plans, then the one that costs more is likely to be the more generous, and thus preferred, one. This worker is also likely to be more attached to the labor force.

A third criterium selects the worker designated as the "head of household." In the MEPS, the head of household is the member who owns or pays rent the home. However, a substantial fraction of the heads of household are unemployed, suggesting that it mis-measures the object in question: which household member is the preferred source of private medical insurance. A household member who is not strongly attached to the labor force would not be preferred, because the coverage would go away when the member left the labor force. Because of this, the second criteria is used.

The data distinguish single coverage from family coverage. Ideally, these coverage types would be separated, and the value of each medical insurance plan could depend upon the household members it covers. However, the estimates of Olson (2002) do not distinguish between single and family plans. Olson's (2002) estimates are used to pin down sensible CRRA coefficients. The distribution, and the number of households who choose medical insurance, imply a compensating differential. If the implied compensating differentials are similar to those in Olson (2002), then the range of CRRA coefficients is correct.

The sample is pared down using the following criteria: the job must pay at least the federally mandated minimum wage, for over thirty hours a week. The employee must be between the ages of twenty-two and sixty-two, in order to avoid complications due to parental insurance or Medicare.

Two methods are used to fit the empirical distribution. The first is a non-parametric kernel density estimation. The second assumes that the insurance premia are distributed log-normally. The empirical distributions, as well as the two fits for each, are shown in Figure 2.3. Each of the subfigures corresponds to whether the condition profile is known ("fitted") or estimated ("forecast"), and a CRRA coefficient of one, two or three.

As Figure 2.3 indicates, both of these methods produce similarly fitted distributions. Elasticities for the estimated non-parametric distributions can be found in Table 2.5.

The lognormal assumption allows for estimating a variance of the elasticity. For a lognormal distribution with mean μ and standard deviation σ, the elasticity is determined by:

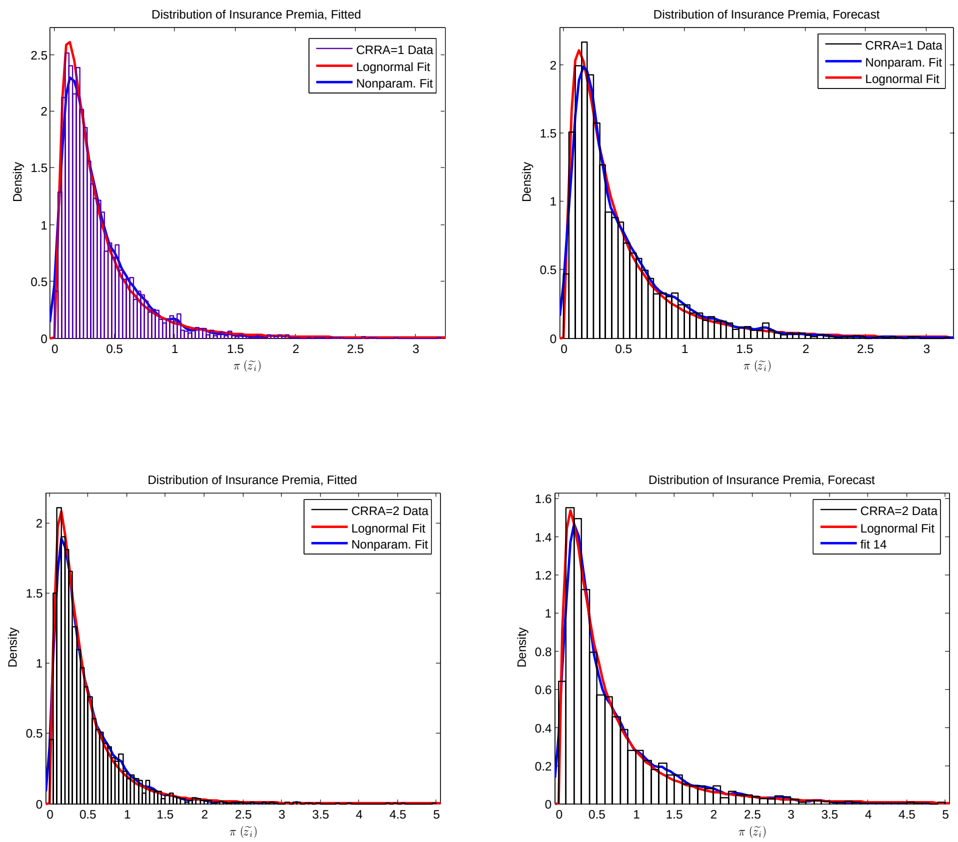
$$\epsilon_L = \frac{\varpi}{\sigma}\left(\frac{\phi_{ln}(\frac{\varpi-\mu}{\sigma})}{\Phi_{ln}(\frac{\varpi-\mu}{\sigma})}\right), \tag{2.8}$$

where ϕ_{ln} and Φ_{ln} are the PDF and CDF of the lognormal distribution. The standard error of the elasticity is calculated using the delta method. Since ϖ and $\Phi_{ln}(\frac{\varpi-\mu}{\sigma})$ are known, the variance in the estimates $\widehat{\mu}$ and $\widehat{\sigma}$ lead to variance in the estimated elasticity in the first term of Equation (2.8), and the numerator of the second. This leads to the variance of the estimated elasticity:

$$\begin{aligned}
Var(\epsilon_L) &\approx \begin{bmatrix} Var(\widehat{\mu}) & Var(\widehat{\sigma}) \end{bmatrix} \begin{bmatrix} (\frac{\partial \epsilon}{\partial \mu})^2 \\ (\frac{\partial \epsilon}{\partial \sigma})^2 \end{bmatrix} \\
&= Var(\widehat{\mu}) * \left(\frac{\varpi \phi'_{ln}(\frac{\varpi-\widehat{\mu}}{\widehat{\sigma}})}{\widehat{\sigma}^2 \Phi_{ln}(\frac{\varpi-\widehat{\mu}}{\widehat{\sigma}})} \right)^2 \\
&+ Var(\widehat{\sigma}) * \left(\frac{\varpi}{\widehat{\sigma}^2 \Phi_{ln}(\frac{\varpi-\widehat{\mu}}{\widehat{\sigma}})} [\phi_{ln}(\frac{\varpi-\widehat{\mu}}{\widehat{\sigma}}) + \frac{\varpi-\widehat{\mu}}{\widehat{\sigma}} \phi'_{ln}(\frac{\varpi-\widehat{\mu}}{\widehat{\sigma}})] \right)^2.
\end{aligned}$$

The estimated variances, along with their point estimates, can be found in Table 2.4. The approximation is allowed because the covariances between the estimates of $\widehat{\mu}$ and $\widehat{\sigma}$ are very small (on the order of 10^{-20}). Since $\widehat{\mu}$ and $\widehat{\sigma}$ are distributed normally, the estimates of ϵ_L are distributed normally.

The estimates of the elasticities and their 95% confidence intervals are all between one and two. The estimates are larger when the condition profile is forecasted. The difference in the lognormal fits is due primarily to the differences in their estimated $\widehat{\sigma}$'s.



As mentioned, comparing the implied compensating differentials to the ones found in Olson (2002) is a way to evaluate different coefficients of relative risk aversion. If the estimation of insurance premia when condition profile is known underestimates the value of medical insurance, then a CRRA coefficient of three is too large. Likewise, if the forecasting method overestimates the insurance premia, then a CRRA coefficient of one is too small. This suggests that a CRRA coefficient around two is best.

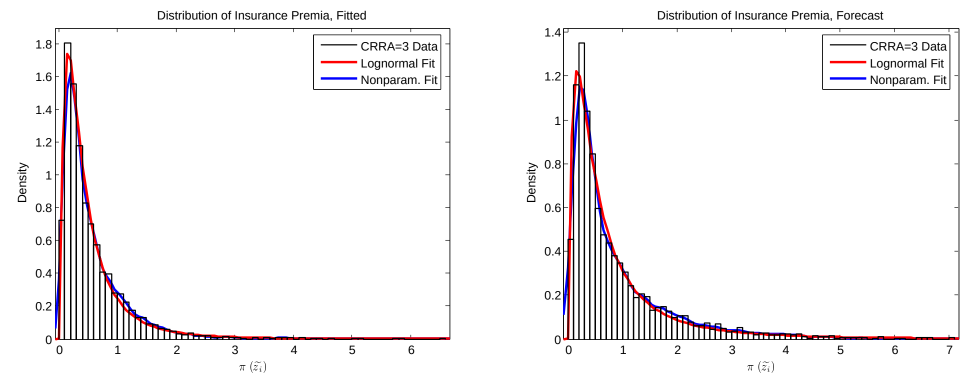


Figure 2.2: Distributions of Insurance Premia, by CRRA Coefficient and Estimation Procedure.

2.3.1 Changing the Tax Code

The estimates $\widehat{\epsilon}$ and $\widehat{\epsilon_L}$ suggest how minor tax reforms will change the market supply for jobs without private medical insurance. What would happen if these changes were major? What would happen if private medical insurance were taxed at the same rate as wages, subject to Federal income and FICA taxes?

One result of the theoretical model is that taxing firms' expenditure on private medical insurance has different results than taxing the workers. If the workers are taxed at their marginal rate, $\tau = \phi_i^m$, then there is no longer a subsidy of private medical insurance through the compensating differential, and $\widehat{\pi}(\widetilde{z}_i) = \pi(\widetilde{z}_i)$. If $r = 2$ and condition profiles are known ("fitted"), roughly half of the workers in the sample would choose to forgo private medical insurance, doubling the number of uninsured workers.

If firms are taxed, then there is still some subsidization. In order to reflect this proposed tax scheme, the after-tax insurance premia are $\pi'(\widetilde{z}_i) = \frac{\pi(\widetilde{z}_i)}{1+\phi_i^m}$. The effects here are less dramatic, as theory suggests. Using the same distribution as before, roughly 37% of the workers would choose to forgo medical insurance, compared to one quarter in the current scheme. These effects are large, but so are the marginal tax rates. It should not be surprising to see such large changes when *ad valorem* subsidies as large as fifty percent are removed.

2.4 Review

Previous attempts to measure the effect of Federal tax law on the private medical insurance choices of workers have focused on the price elasticity for individual workers. Their results are interpreted as measuring the effects on the intensive margin—how does the average worker's propensity to have private medical insurance adjust as the marginal tax rate adjusts? Measures on the intensive margin are less conceptually appealing for discrete choices.

The more pressing policy question is: how many workers will forgo private medical insurance if we end the subsidization of private medical insurance. This chapter provides a framework to address the extensive margin. The procedures described above can be used to estimate demand curves for any kind of insurance.

This chapter also finds that the distortions of US income taxes are very large. The number of workers without private medical insurance would increase by half if it were taxed as income. Other tax-exempt workplace benefits and amenities are likewise overconsumed. Tax-exempt income sources are subject to these distortions, as well.

This chapter finds that removing the tax subsidy of private medical insurance would lead to large changes in the number of workers with private medical insurance. Such changes would likely lead to an increased cost of private medical insurance. Thus, the estimates of the market elasticity provided here are lower-bound measures of the true effects.

Table 2.1: Estimates for the Heckit procedure: probability of conditions on private HI expenditure

	Expenditure		1==Insured	
	Est.	SE	Est.	SE
Age	.4731921	.8205193	.0513394	.0064774
Age^2	.0018056	.0100435	-.0004966	.0000849
1==Male	29.29986	19.06743	.1848905	.165913
Age*Male	-1.61748	1.039742	-.0090381	.0093571
Age^2*Male	.0175994	.0132971	.0001475	.0001223
Hypertension	22.95935	3.38623	-.0261127	.034318
Lipid Disorder	18.06541	4.65352	.3438363	.0490877
Pregnancy	49.5938	5.060971	-.2032856	.0388463
Diabetes	49.68642	5.717271	-.3631525	.0464548
Psychol.	24.24095	3.244273	-.1649887	.0283652
Cancer	61.32173	4.782201	.3551595	.0507559
Sinusitis	3.402318	4.523483	.388404	.0452294
Allergies	3.835251	3.865903	.36683	.0349636
Other	23.52663	3.678306	.3518505	.0214878
Family Condition	—	—	.2411545	.0347603
Constant	-17.81937	22.53788	-.9659483	.116528
λ	-1.36691	14.25534		

Table 2.2: Individual's Condition Profile Estimates

	Hypertension		Lipid Disorder		Pregnancy	
	Est.	SE	Est.	SE	Est.	SE
Age	-.000953	.0008463	.0023785	.0006845	-.0187346	.0005112
1==Male	-.0190249	.0549945	-.2119737	.0444801	-.49255	.0332186
Age^2	.0001092	8.50e-06	.000019	6.87e-06	.0001372	5.13e-06
Age*Male	.0008904	.0012756	.0020081	.0010318	.0189609	.0007705
Age^2*Male	-.0000181	.000013	-.0000178	.0000105	-.0001393	7.87e-06
1==Smoker	-.007327	.0053122	-.008966	.0042965	-.0076054	.0032087
BMI	.0143962	.0011824	.0061929	.0009564	.0056277	.0007142
BMI^2	-.0000643	.0000161	-.0000467	.0000131	-.0000521	9.75e-06
BMI*Male	-.0008596	.0032731	.0107651	.0026474	-.0068733	.0019771
BMI^2*Male	.0000342	.0000505	-.0001478	.0000409	.0000718	.0000305
1==Asian	-.0511157	.0196008	.0531056	.0158533	-.0095594	.0118395
1==Black	-.0473304	.0118781	.0234137	.0096071	-.0011316	.0071748
1==Other Race	-.0763052	.0060195	.0367693	.0048686	.0040515	.003636
1==Hispanic	-.008574	.0053032	-.0373988	.0042892	.0104963	.0032033
Constant	-.2964054	.0267183	-.2205474	.02161	.5027256	.0161388
R^2	0.23		0.09		0.17	
	Diabetes		Psychological Disorder		Cancer	
Age	.0006915	.0006223	.0077592	.0008543	.0025836	.000613
1==Male	.0749468	.0404434	.2108511	.0555165	.0301009	.0398364
Age^2	.0000279	6.25e-06	-.0000672	8.58e-06	-7.17e-06	6.15e-06
Age*Male	.0000234	.0009381	-.0050546	.0012878	-.0057194	.000924
Age^2*Male	4.49e-06	9.59e-06	.0000511	.0000132	.0000714	9.44e-06
1==Smoker	-.0048522	.0039066	.0675008	.0053626	-.0204152	.003848
BMI	.0103229	.0008696	.0064283	.0011937	-.0000613	.0008565
BMI^2	-.0000544	.0000119	-.0000358	.0000163	-5.45e-06	.0000117
BMI*Male	-.0060933	.0024071	-.0113827	.0033042	.0024407	.002371
BMI^2*Male	.0001046	.0000372	.0001518	.000051	-.0000299	.0000366
1==Asian	-.0032603	.0144145	.0869442	.0197868	.0115296	.0141982
1==Black	-.0165615	.0087352	-.0299766	.0119908	-.0053294	.0086041
1==Other Race	-.0429732	.0044267	.0503595	.0060766	.0422633	.0043603
1==Hispanic	.0307456	.0039	-.0501532	.0053535	-.0451661	.0038415
Constant	-.2314491	.0196488	-.1988932	.0269719	-.0363606	.019354
R^2	0.09		0.04		0.05	
	Sinusitis		Allergies		Other	
Age	.003931	.0005764	.0063144	.0007343	.0019051	.0009644
1==Male	.0343906	.0374582	.0614089	.0477159	.0119447	.0626755
Age^2	-.0000431	5.79e-06	-.0000658	7.37e-06	7.40e-06	9.68e-06

Age*Male	-.0022962	.0008689	-.0056759	.0011068	-.0026693	.0014538
Age^2*Male	.0000218	8.88e-06	.0000548	.0000113	.0000474	.0000149
1==Smoker	-.0035772	.0036182	-.0343774	.0046091	.0204546	.0060541
BMI	.0023497	.0008054	.0026359	.0010259	.0088428	.0013476
BMI^2	-.0000247	.000011	-.0000202	.000014	-.0000676	.0000184
BMI*Male	-.0007219	.0022294	.0018062	.0028399	-.0082088	.0037303
BMI^2*Male	3.01e-06	.0000344	-.0000317	.0000439	.0001505	.0000576
1==Asian	.0127106	.0133506	.0248955	.0170066	.0599365	.0223384
1==Black	-.020154	.0080904	.0335193	.010306	-.0392999	.013537
1==Other Race	.0405918	.0041	.0445266	.0052228	.105774	.0068602
1==Hispanic	-.062902	.0036121	-.045784	.0046013	-.1639062	.0060438
Constant	-.06515	.0181985	-.0921705	.0231821	.5056103	.03045
R^2	0.02		0.02		0.09	

Table 2.3: $\widehat{\Phi}$, the estimated variance-covariance matrix of the Condition

	Hypertension	Lipid Dis.	Pregnancy	Diabetes	Psych. Dis.	Cancer	Sinusitis	Allergies	Other
Hypertension	.11330161								
Lipid Dis.	.01742072	.07411876							
Pregnancy	-.00058696	-.00014421	.04133893						
Diabetes	.0143457	.01014217	-.0002909	.06127614					
Psych. Dis.	.0060794	.00448683	-.00131902	.00362278	.11546263				
Cancer	.0020795	.00134997	-.00053866	.00007842	.00238103	.05945084			
Sinusitis	.00138417	.00113579	-.00061187	.00001494	.00268409	.00158058	.05256425		
Allergies	.00298581	.00246114	-.00192169	.00044035	.00621115	.00251097	.00911919	.08529487	
Other	.0102641	.00601183	-.0003117	.00472245	.01401945	.00429751	.00462182	.00860729	.1471608

Table 2.4: Estimates for the Heckit procedure: probability of conditions on private HI expenditure

	Expenditure		1==Insured	
	Est.	SE	Est.	SE
Pr(Hypertension)	-56.83501	53.4025	2.553709	.540297
Pr(Lipid Disorder)	-123.3155	49.30362	3.713421	.4960758
Pr(Pregnancy)	-17.04967	23.93567	-1.291404	.2366441
Pr(Diabetes)	276.0879	100.3699	-7.469384	1.018011
Pr(Psychol.)	-24.45859	38.87041	-5.137798	.4000075
Pr(Cancer)	193.5422	90.33039	-5.836164	.924048
Pr(Sinusitis)	-138.3407	165.5682	2.237323	1.774985
Pr(Allergies)	-35.54377	76.15171	5.58042	.8294379
Pr(Other)	160.0056	71.16331	4.157687	.7354532
Family Condition	—	—	-.2576775	.1494431
Constant	-82.60812	41.94979	-2.322584	.4255944
λ	-1.420048	4.331656		

Table 2.5: Elasticity of labor supply relative to compensating differential

Method	CRRA	CDF	PDF	ϖ	Elasticity
Fitted	1	25	2.29975	.145	1.33
	2	25	1.89123	.175	1.32
	3	25	1.62837	.200	1.30
Forecast	1	25	1.99005	.173	1.38
	2	25	1.46049	.220	1.29
	3	25	1.16261	.262	1.22

Table 2.6: The CDF is taken from the data, as the percentage of jobs in the sample without private medical insurance. The PDF is determined from a kernel density estimation of the empirical distribution values of private health insurance to the household, as described in the text. ϖ is the implied compensating differential, from that distribution and the CDF. The elasticity is calculated using the formula from the text. The CRRA coefficients have been selected to: (1) sample a range of sensible coefficients; and (2) yield implied ϖ's that fit previous empirical estimation.

Method	CRRA	CDF	ϖ	$\hat{\mu}$ (SE)	$\widehat{\sigma}$ (SE)	Elasticity (SE)	Log(L)
Fitted	1	25	.145	-1.3711 (0.013)	0.87349 (0.009)	1.70 (0.0326)	408.059
	2	25	.175	-1.14787 (0.013)	0.893281 (0.009)	1.60 (0.0302)	-737.546
	3	25	.200	-0.97989 (0.013)	0.919079 (0.010)	1.49 (0.0277)	-1654.01
Forecast	1	25	.173	-1.1596 (0.014)	0.946801 (0.010)	1.46 (0.0304)	-945.074
	2	25	.220	-0.847513(0.015)	1.02158 (0.011)	1.24 (0.0264)	-2738.7
	3	25	.262	-0.623185(0.016)	1.07224 (0.011)	1.11 (0.0266)	-4007.65

Table 2.7: The CDF is taken from the data, as the percentage of jobs in the sample without private medical insurance. ϖ is the implied compensating differential. $\hat{\mu}$ and $\widehat{\sigma}$ are the mean and standard deviation of the fitted lognormal distribution, respectively. The elasticity is provided, along with a standard error found using the delta method and the variance-covariance matrix of $\hat{\mu}$ and $\widehat{\sigma}$, as discussed in the text. Log(L) is the log-likelihood of the fit.

Chapter 3

Optimal Replacement Rates in a Search Economy: Endogenizing UI

The benefits and taxes of unemployment insurance (UI) vary greatly across administrative regions. This is commonly characterized by contrasting the US and the more generous and costly European systems. As reported in Martin (1996), within OECD Europe, replacement rates can vary from under thirty percent (Ireland), to seventy percent or higher (Denmark, Netherlands, Sweden, Switzerland.) US UI is administered on the state level, and varies accordingly. Gruber (1994) imputes replacement rates for the PSID sample; replacement rates vary greatly across states, with a secular decline in benefits over time.

One obvious reason—the reason which is the focus of this chapter— behind these differences is variety in bargaining power across UI administrative regions. Since the value of higher benefits come at the cost of diminished rent to be divided between the firm and the employee, the optimal tax level balances lowered wages for the employed with the consumption replacement for the unemployed.

Given variety in benefit schedules, I posit a positive model of optimal replacement rates, designed to balance consumption of employment periods versus consumption while unemployed. I consider why UI systems are different in their generosity to the unemployed, at the cost of taxing the productive matches in an economy.

Nash bargaining is used here to determine the wage of a filled vacancy. One implication of Nash bargaining is that full insurance can only be achieved for some values of the Nash bargaining parameter. This is because Nash bargaining aims to maximize the surplus of a filled vacancy. If full insurance is achieved, then the worker receives no surplus from employment, and the Nash surplus is zero.

When using Nash bargaining, it is common to assume the symmetric value, $\beta = 1/2$, or one of two extreme values, $\beta \in \{0, 1\}$. Only a few estimates of β exist in the literature, as the data demands for the estimation are severe.[1]

The second section of this chapter presents a simplified model economy, to develop some intuition of the costs and benefits of a UI system, and the conditions for UI optimality. The third section provides for the calibration of β. The fourth section works with replacement rate data from the US to estimate β. The fifth section concludes.

3.1 The Model

Consider a continuous-time labor search economy with a matching function of the form $m(u, v) = pu$. That is, some fraction p of the unemployed agents in the economy are matched with a vacancy. Thus, the probability of an unemployed agent becoming employed is $p(u, v) = m(u, v)/u = p$, which is constant across unemployment levels and vacancy rates. The probability that a vacancy is filled,

[1] Four examples of this estimation can be found in Cahuc, Postel-Vinay and Robin (2006), Flinn (2006), Abowd and Allain (1996) and Cahuc, Gianella, Goux and Zylberberg (2002). See the calibration and estimation section for further discussion.

$q(u,v) = m(u,v)/v$, can be written in terms of $\theta = v/(1-n)$, the ratio of vacancies to unemployed: $q(\theta) = p\theta^{-1}$.[2]

Filled vacancies create rent z. Filled vacancies are destroyed at an exogenous rate of δ. There is a unit measure of agents, whose utility of consumption is governed by a generic utility function $u(\cdot)$. The proportion of them unemployed is $1-n$, while n are employed.

3.1.1 Nash Bargaining with Non-Linear Utilities: Taxing the Firms

In this economy, I write continuous-time value functions for being employed at a wage w and unemployed receiving benefits b, respectively

$$\begin{aligned} rV_e &= u(w+F) + \delta(V_u - V_e) \\ rV_u &= u(b+F) + p(V_e - V_u). \end{aligned}$$

F is a lump-sum transfer given to each agent. For the firm, I have two value functions: one for a filled vacancy at a wage w, and one for an unfilled vacancy, respectively

$$\begin{aligned} rV_f &= (z - w - \tau) + \delta(V_v - V_f) \\ rV_v &= -c + q(V_f - V_v). \end{aligned}$$

Here, c is the cost of posting a vacancy. The firm is being taxed at some level τ, which is used to finance the U.I. system; this taxation is modeled as decreasing the rent of a filled vacancy. The surplus for being employed for a worker can be solved from above as

$$V_e - V_u = \frac{u(w+F) - u(b+F)}{r+\delta+p}. \tag{3.1}$$

[2] This is essentially the typical search model with a Cobb-Douglas matching function with the matching elasticity set to $\eta = 1$.

Free entry drives $V_v \to 0$, so the surplus for a firm's filled vacancy is

$$V_f = \frac{z - w - \tau}{\delta + r}. \tag{3.2}$$

The Nash Bargaining wage is the wage which solves the following problem

$$w^* = \text{argmax}_w \left(\frac{u(w+F) - u(b+F)}{r + \delta + p} \right)^{\beta} \left(\frac{z - w - \tau}{r + \delta} \right)^{1-\beta}. \tag{3.3}$$

subject to two participation constraints: for the worker, $w - b \geq 0$, and for the firm, $z - \tau - w \geq 0$. These two constraints only bind in the extreme cases where $\beta = 0$ and $\beta = 1$, respectively. The Nash-bargaining wage is given by the equation

$$z - \tau = w + \frac{1-\beta}{\beta} \frac{u(w+F) - u(b+F)}{u'(w+F)}. \tag{3.4}$$

It is also useful to think about how the wage changes as the tax levels and benefits change across steady-states. The steady-state conditions are:

$$\begin{aligned} n\tau &= (1-n)b && (3.5) \\ F &= nV_f = n\frac{z - w - \tau}{r + \delta} && (3.6) \\ n\delta &= (1-n)p. && (3.7) \end{aligned}$$

The first equation is a government-budget constraint: the "taxes in" equal the "benefits out." The second accounts for the lump-sum transfers to all agents, which are paid for by the profits earned by the filled vacancies.[3] The third ensures an unchanging unemployment rate: the jobs destroyed equal the jobs created.

[3] This can be thought of as communal ownership of the firms through non-transferable stock, or taxation of the firm by the government, which returns all of the value of the firm to the workers. This is to account for the value of the firm in the optimization problem.

The Implicit Function Theorem and (3.5) and (3.7) combine to yield

$$\frac{\partial w}{\partial \tau} = -\frac{1 - \frac{1-\beta}{\beta}\frac{u'(b+F)}{u'(w+F)}\frac{p}{\delta}}{1 + \frac{1-\beta}{\beta}\frac{u'(w+F)^2 - u''(w+F)[u(w+F)-u(b+F)]}{u'(w+F)^2}}. \tag{3.8}$$

The denominator is negative, and while the numerator is ambiguous in sign.

Theorem. $\frac{\partial w}{\partial \tau} < 0$ *iff*

$$\beta > \frac{\frac{p}{\delta}\frac{u'(b+F)}{u'(w+F)}}{1 + \frac{p}{\delta}\frac{u'(b+F)}{u'(w+F)}}. \tag{3.9}$$

That is, if $u' > 0, u'' < 0$, and an increase in benefits dramatically increases the ratio of marginal utility of the benefits to marginal utility of the corresponding wage, then the a tax increase could be associated with an *increase* in wages. The Nash bargaining mechanism is behind this otherwise counterintuitive result: because the worker is doing better while unemployed, maximizing weighed *surplus* requires increasing the reward of being employed—that is, increasing the wage. This, of course, is dependent upon $\frac{\partial b}{\partial \tau} = p/\delta$, which is pinned down according to the two steady-state conditions and the exogenous probability p.

It is also instructive to consider the two extreme values of β. When $\beta = 1$, all of the surplus of the match goes to the worker. The participation constraint of the firm[4], $z - w - \tau \geq 0$, binds; thus $w = z - \tau$. $\frac{\partial w}{\partial \tau} = -1$. Since the wage is all of the after-tax rent of the match, the wage decreases one-to-one as the tax increases.

When $\beta = 0$, the Nash bargaining wage is such that all of the surplus of the match goes to the firm. The participation constraint of the worker is $w \geq b$ (that is, the worker is at least indifferent to participate in the match, versus staying unemployed). Thus, $w = \frac{p}{\delta}\tau$. $\frac{\partial w}{\partial \tau} = p/\delta$. Since the wage is driven down to the unemployment benefit, the wage increases as the tax increases.

The sign of $\frac{\partial w}{\partial \tau}$ also depends upon the curvature of the utility function.

[4]That is, the firm is at least indifferent to participate in the match

$\rho = \frac{b+F}{w+F}$ is the after-transfer replacement rate. For the CRRA utility function parameterized by σ, $u(w) = \frac{w^{1-\sigma}-1}{1-\sigma}$, and a candidate replacement rate, ρ, I can re-write the numerator of (3.8)as

$$1 - \frac{1-\beta}{\beta}\rho^{-\sigma}\frac{p}{\delta}.$$

This allows us to see how the degree of risk aversion, the replacement rate and β play a role in the sensitivity of the wage to taxes.

Since the taxes and benefits will be chosen to solve a maximization problem, it is important to consider whether it is different to tax the firm, as described above, or to tax the employed individual.

Theorem. *If the tax burden is shifted from the firm, to the employed worker as a lump-sum income tax, the wage increases by the level of the tax. I.e., the worker's after-tax wage returns to the level when taxes were paid by the firm.*

Proof. I can consider an alternative tax system where the employee pays an "income tax" of τ upon employment; this income tax pays for unemployment benefits. I can re-write (3.4):

$$\begin{aligned} z &= w + \frac{1-\beta}{\beta}\frac{u(w+F-\tau) - u(b+F)}{u'(w+F-\tau)} \\ z - \tau &= w - \tau + \frac{1-\beta}{\beta}\frac{u(w+F-\tau) - u(b+F)}{u'(w+F-\tau)}. \end{aligned}$$

Note that the function of w on the right-hand side of (3.10) is the same as the right-hand side of (3.4), but shifted to the right by τ. The the left-hand side of both equations is $z - \tau$, so versus the wage determined by firm taxation, the wage increases by τ to compensate. □

3.1.2 Firms and Free Entry

Free entry leads to $V_v \to 0$ and determines the number of vacancies in the economy. The vacancy rate is determined endogenously by:

$$v = \frac{(1-n)p}{r+\delta}\frac{z-w-\tau}{c} \tag{3.10}$$

This implies that $z - w - \tau \geq 0$.

Theorem. *Free entry ensures that $V_f \geq 0$.*

Proof. The values of a vacancy and matched firm can be rearranged to get closed-form values for V_f and V_v.

$$\begin{aligned} V_f &= (r+\delta-\frac{q\delta}{r+q})^{-1}(z-w-\tau-\frac{\delta}{r+q}c) \\ V_v &= (r+q-\frac{q\delta}{r+\delta})^{-1}(-c+\frac{q}{r+q}(z-w-\tau)) \end{aligned}$$

$V_v = 0$ implies $z - w - \tau - \frac{r+\delta}{q} = 0$. From this, the key inequality is:

$$\frac{r+\delta}{q} - \frac{\delta}{r+q} = \frac{r^2 + r(\delta+q)}{q(r+q)} > 0$$

The coefficient in front of c in (3.1) is smaller than it is in the free-entry condition, so $V_f > 0$.

Alternatively, $V_f = c/q > 0$. □

Theorem. *The Firm's participation constraint, $V_f \geq 0$ is satisfied for all candidate tax-benefit schedules that satisfy the agent's participation constraint, $w \geq b$.*

Proof. From the Nash bargaining equation, I can write the value of the firm in terms of the after-transfer replacement rate:

$$V_f = \frac{1-\beta}{\beta(r+\delta)}\frac{u(w+F)-u(b+F)}{u'(w+F)}.$$

This value is greater than zero so long as the after-transfer replacement rate is less than or equal two zero. □

3.1.3 Optimal Tax Rates

The closed-form value functions for being employed and unemployed are, respectively

$$\begin{aligned} V_e &= \frac{1}{r+\delta-\frac{p\delta}{r+p}}\left(u(w+F)+\frac{\delta}{r+p}u(b+F)\right) \\ V_u &= \frac{1}{r+p-\frac{p\delta}{r+\delta}}\left(u(b+F)+\frac{p}{r+\delta}u(w+F)\right). \end{aligned}$$

The generalized maximization problem faced by the government setting UI policy is

$$\max_{\tau} \lambda V_e + (1-\lambda)V_u, \tag{3.11}$$

subject to the two government budget constraints(3.5and 3.6), the wage determination equation (3.4), and steady-state employment (3.7). λ is the relative weight placed on the employed worker, $1-\lambda$ for the unemployed worker. There are three special cases:

- $\lambda = 1$, maximize the value of the employed; if $n > .5$, also a majoritarian rule;
- $\lambda = 0$, maximize the value of the unemployed; if $n > .5$, a maximin rule;
- $\lambda = n$, maximize the average utility in the economy.

The maximization problem for some λ can be written

$$\max_{\tau}(\lambda r+p)u(w+F)+((1-\lambda)r+\delta)u(b+F) \tag{3.12}$$

The first-order condition in terms of τ is

$$\begin{aligned}(\lambda r+p)(\frac{\partial w}{\partial\tau}(1-\frac{p}{(p+\delta)(r+\delta)})-\frac{p}{(p+\delta)(r+\delta)})u'(w+F)&\\ +((1-\lambda)r+\delta)(\frac{p}{\delta}-\frac{p}{(p+\delta)(r+\delta)}(1+\frac{\partial w}{\partial\tau}))u'(b+F)&=0\end{aligned} \quad (3.13)$$

holds for interior solutions, such that the pre-transfer replacement rate (defined by $\widehat{\rho}=b/w$) is between zero and one; or alternatively, that τ is between zero and the tax level that accommodates full insurance.

Theorem. *If wages are convex in taxes (i.e., $\frac{\partial^2 w}{\partial\tau^2}>0$), then the objective function is concave in τ.*

This result is derived simply from the second-order equation of the objective function. The convexity of wages in taxes is not guaranteed throughout the parameter space. However, for when the convexity assumption is satisfied, some results follow that add to the intuition of the problem. Below, there will be some discussion of non-convexity, i.e., when there may be multiple τ that satisfy the (3.13), so that I may order the preference across these τ.

The two corner solutions are when the replacement rate is either one or zero. It is important to understand where in the parameter space a replacement rate of one is optimal, since it virtually eliminates those spaces as possible estimated values, as full replacement is not typically observed. Similarly, taxes for unemployment insurance is observed to be larger than zero, so the parameter space where $\tau=0$ would be similarly ruled out.

Theorem. *If wages are convex in taxes, the optimal tax level is $\tau=0$ if*

$$\frac{u(\widetilde{w}+\widetilde{F})}{u(\widetilde{F})}>\frac{\lambda r+p}{(1-\lambda)r+\delta}$$

where $\widetilde{w},\widetilde{F}$ are the wage and transfer when $\tau=0$.

Proof. The value of the lump-sum transfer when $\tau = 0$, $F|_{\tau=0}$, is determined by the wage when $\tau = 0$, which solves

$$z = w + \frac{1-\beta}{\beta}\frac{u(\frac{n}{r+\delta}z + (1-\frac{n}{r+\delta})w) - u(\frac{n}{r+\delta}z + \frac{n}{r+\delta}w)}{u'(\frac{n}{\delta}z + (1-\frac{n}{\delta})w)}.$$

Thus, $F|_{\tau=0} = \frac{n}{r+\delta}(z-w)$. Evaluation of (3.13) at $\tau = 0$ yields constraints on β that it be outside $[0,1]$ to maintain equality if the theorem's inequality holds. Thus, since $\beta \in [0,1]$, the optimal $\tau = 0$. □

As shown below, this condition will not likely hold, because $p > 10\delta$ for most countries, and calibrated values of F are typically large. This is suggestive of transfers playing a substantial role in the consumption of agents.

Theorem. *If wages are convex in taxes, the optimal replacement rate is equal to one if*

$$\beta \leq \frac{n(\lambda r + p + n) + ((2-\lambda)r + 2\delta)n - n(1-n)(1+\frac{p}{\delta})}{\lambda r + p + n}$$

Proof. This inequality comes from evaluating (3.13) at $\rho = 1$; if this value is positive, then the participation constraint of the worker binds. □

For typical calibrations (see below) this implies that a β below .4 results in a replacement rate of one. This is much less restrictive than when the value of the firm is not rebated to the workers in a lump-sum fashion.

If Value of Firm is not returned to the Agents

If the value of the firm is not rebated to the agents, then it can be shown that if $\beta \leq n = \frac{p}{p+\delta}$, then the optimal UI policy would be full insurance.

Theorem. *If* $\beta < \frac{1}{1+\delta/p} = n$*, then the optimal replacement rate is* $\rho^* = 1$*.*

The first-order condition is

$$(\lambda r+p)\frac{\partial w}{\partial\rho}u'(w)+((1-\lambda)r+\delta)(w+\rho\frac{\partial w}{\partial\rho})u'(\rho w)\geq 0. \tag{3.14}$$

With $F=0$, the wage rate can be determined purely in terms of the replacement rate and other parameters:.

$$w=\frac{z}{1+\frac{\delta}{p}\rho+\frac{1-\beta}{\beta}\frac{1-\rho^{1-\sigma}}{1-\sigma}}. \tag{3.15}$$

This condition holds with equality when $\rho^*\in(0,1)$. However, if $\frac{\partial w}{\partial\rho}\mid_{\rho=1}\geq 0$, then $\rho^*=1$, since the participation constraint of both the firm and the worker bind. In fact, these constraints bind for particular parameter values.

$$\frac{\partial w}{\partial\rho}|_{\rho=1}=\frac{-z\frac{\delta}{p}+z\frac{1-\beta}{\beta}\rho^{-\sigma}}{(1+\frac{\delta}{p}\rho+\frac{1-\beta}{\beta}(\frac{1-\rho^{1-\sigma}}{1-\sigma}))^2}|_{\rho=1}=\frac{z(\frac{1-\beta}{\beta}-\frac{\delta}{p})}{(1+\frac{\delta}{p})^2}. \tag{3.16}$$

So, if $\beta<\frac{1}{1+\delta/p}=n$, then the optimal replacement rate is one. Since this is a a condition that is likely to hold, it severely restricts the values of β that can lead to replacement rates of less than one.

3.1.4 Non-Convex Objective Function

Theorem. *If multiple τ satisfy (3.13) as maxima, then the optimal τ is the one associated with the lowest F. Further, the lowest F is the associated with the largest τ.*

Proof. The total output of the economy is $nz-cv$. Since the only object in the total output of the economy that moves according to the tax level is v, and it enters negatively. v is increasing in $z-w-\tau$, as is F, per (3.6). Thus, larger F means more vacancies, and more output is spent on posting these vacancies, less is spent on consumption.

The second result stems from $\frac{\partial F}{\partial \tau} < 0$.

$$\frac{\partial F}{\partial \tau} = \frac{-n}{r+\delta}(\frac{\partial w}{\partial \tau} + 1).$$

If $\frac{\partial w}{\partial \tau} > -1$, then $\frac{\partial F}{\partial \tau} < 0$. From (3.8), $\frac{\partial w}{\partial \tau} = -1$ only when $\rho = 1$ and $\beta = 1$, and is larger for all other (ρ, β). □

For the empirical discussion below, the first-order condition (3.13) is assumed to hold, and hold with the highest τ. This is driven by two observations: first, that the pre-transfer replacement rate (i.e., $\widehat{\rho}$, the one funded by τ) is observed to be greater than zero, and less than one; and the operating assumption of this chapter, that these UI policies are optimal.

3.2 Cross-Country Calibration

The construction of the model allows for cross-country calibrations of β, according to varying optimal replacement rates. Previous estimations of bargaining power are few, due mainly to the severe data demands. It is infrequent that firm-level data includes enough information to estimate outside opportunities to firms and employees, and thus the surplus accorded to the firms the employees. Abowd and Allain (1996) and Cahuc et al. (2002) take advantage of French data sets with such information, and estimate β to be within the range of .1 to .4. Here, I use the UI replacement rates of different countries to find their corresponding βs, per the model constructed. I also use the case where $\lambda = 1$, which the objective is to maximize the value of the majority of agents—an employed agent.

The replacement rates for various nations as reported in Table 3.1 are drawn from OECD (2004). At first glance, it may be surprising to see that the European and American replacement rates are not very dissimilar. In particular, this contrasts the tables reported in Martin (1996), later reproduced in Ljungqvist and Sargent

(1998), which place US replacement rates at less than thirty percent. The numbers reported here are the replacement rates for the initial phase of unemployment, while Martin (1996) calculates the replacement rates for the first year of unemployment. For example, in the United States, unemployment benefits typically last 26 weeks; using administrative UI data, Meyer (1990) finds an average replacement rate of 66 percent over the span of eligibility—the duration of the unemployment spell, or when benefits run out, whichever comes first. (In Meyer (1990), the spells average just over thirteen weeks.)

OECD (2004) reports replacement rates for several wage levels relative to mean, and household compositions. In terms of the theoretical model above, these are the pre-transfer replacement rates, $\widehat{\rho} = b/w$. The replacement rates used here for calibration are for those earning the average wage, with no children. In several U.S. states, extra benefits are allowed for recipients with one or more children. In order to focus on the replacement of income, the replacement rates indicated will be used.

Unemployment levels are used to calibrate for p. Steady-state conditions imply $1 - n = \frac{\delta}{p+\delta}$; I assume a common δ, and back out a p from the unemployment rate for each country. To allow for different unemployment levels arising from different labor market institutions beyond the scope of unemployment insurance, I perform this calibration. δ is set so that the weekly employment hazard for a worker is roughly ten percent, per evidence for the initial weeks of unemployment in Meyer (1990). It could be said that the unemployment insurance scheme devised here affects p directly, though a matching function with $\eta < 1$; that is p should be endogenous to the tax scheme. This is an important extension, already being modeled for future work.

It is also important to revisit Meyer (1990). While an important result derived therein was the negative association between replacement rate and employment hazard, even more stunning was the even sharper increase in employment hazard due to benefit exhaustion. As Table 3.1 suggests, the difference in replacement rates between the US and Europe is not large. The important difference between the US and Europe is the duration of benefits; for many European systems, benefits exhaust in years, not weeks. If the availability of benefits are reflected in higher levels of unemployment rate, it will be because of a lower probability of employment, p.

The wages presented are the average wage for a production (non-white collar) worker in each country, as reported in OECD (2004). They are denominated in 2002 US dollars, converted with the OECD's purchasing parity parities (PPP). Productivity level, z, for each country is derived from the labor share of each country; i.e., $z_c = s_c^l w_c$. The labor shares are also from the OECD, reported for each country. From these, I find the lump-sum transfer, F, for each country.

β_C^1 and $\beta_C^{1.5}$ are the calibrated values of Nash bargaining, for log- and CRRA coefficient of 1.5 utility, respectively. The smallest Nash bargaining weight consistent with replacement rate of less than one is reported as β_1. The implied after-transfer replacement rate is reported as ρ.

The largest calibrated Nash bargaining weights can be found in the low-employment, generous-benefits countries, such as the Netherlands and Denmark. Ungenerous Ireland also has a large estimated Nash bargaining weight for workers. Countries with large unemployment rates are seen as having lower bargaining powers. For the Canada, using the symmetric Nash bargaining value of $\beta = .5$ is not terribly far off from calibrations of .53. The French value of .45 is similar to Abowd and Allain (1996), who estimated a Nash bargaining power of .4 in French firms.

The US and the United Kingdom have similar average wage levels and unemployment. They differ, however, in their replacement rates, with the US replacing more income than the United Kingdom. Bargaining power in the US is calculated to be lower than in the United Kingdom. Because wages in the US are less sensitive to taxes than in the United Kingdom, optimal pre-transfer replacement rates are higher.

The unemployment rates, through the employment hazard, drive a lot of the Nash bargaining calibrations. High unemployment rates make it relatively more expensive to increase unemployment benefits. E.g., a country with five-percent unemployment gets an extra 19 units of benefits for a tax increase of one unit, while a country with ten-percent unemployment gets just over half of that (10) for the same increase in tax. Thus, in order to finance the higher replacement rates on wages (i.e., pre-transfer replacement rate), the worker should be less sensitive to the effects of those taxes on wages.

The calculated after-transfer replacement rates are all very close to full replacement. This is because the values of the firms are very large, due to the small values for r and δ; thus, the size of F dominates the the pre-transfer replacement rate, $\widehat{\rho}$, in determining the after-transfer replacement rate ρ.

3.3 GMM Estimations

For individual i, with employment hazard p_i, receiving benefits b according to previously earned wage w, the optimal replacement rate satisfies:

$$\begin{aligned}(\lambda r + p_i)(\frac{\partial w}{\partial \tau}(1 - \frac{p}{(p+\delta)(r+\delta)}) - \frac{p}{(p+\delta)(r+\delta)})u'(w+F) \\ +((1-\lambda)r+\delta)(\frac{p}{\delta} - \frac{p}{(p+\delta)(r+\delta)}(1+\frac{\partial w}{\partial \tau}))u'(b+F) \quad = 0. \quad (3.17)\end{aligned}$$

UI benefit level calculations include the wage level of the previous job, and more infrequently, number of children and marital status (as a matter of needs, not affecting employment hazard). However, as equation (3.17) suggests, any variable which effects p_i should be included in the calculation. Individual characteristics such as age, race, education, children and marital status have significant effects on employment hazard, though they are not accounted for in replacement rates. Equation (3.17) should equal zero on average; however, since individual employment hazards (p_i) vary around the average unemployment level (p), there is a systematic error structure. Since p_i occurs linearly in (3.17), the expectation across i is zero.

It is important to differentiate between p and p_i. Where p occurs, it appears through the government budget constraint, (3.5), or steady-state employment level and level of lump-sum benefits, (3.7, 3.6). As p_i varies across individuals, it does not shift the economy's employment level, or, concomitantly, the amount of lump-sum transfers, or how benefits move in response to changes in taxes (i.e., $\frac{\partial b}{\partial \tau} = p/\delta = n/(1-n)$).

Variance in p_i lead to variance in optimal replacement rates through the value functions of the employed and unemployed agents. For example, if one individual had a very low probability of leaving unemployment, their replacement rate would be higher than a high-probability. Again, since there are a large number of agents in the economy, that heterogeneity in employment hazards does not change the unemployment level, and thus the government budget constraint.

3.3.1 The Data

The data used here come from "An Analysis of UI Recipients' Unemployment Spells," a report from the Upjohn Institute. The wage and benefit levels are reported from a sample of the Continuous Wage and Benefit History (CWBH), which is a collection of UI benefit records. Observations are recipients from Missouri and Pennsylvania, whose benefit receipt began between October 1979 and March 1980. Further information was collected via phone and mail surveys one year later.[5]

The sample means are provided in Table (3.2). The average replacement rate constructed here is lower than in other reported samples, due to its construction.

[5] A similar sample was used in Meyer (1990).

The data report reliable weekly benefits given to the unemployed worker. Here, the wage that is being replaced is the highest quarterly income of the previous year of employment, rather than some average wage over that span, since UI benefit levels are typically calculated from the high-quarter earnings. The average duration of unemployment is just longer than 15 weeks. Due to data collection issues described in Upjohn (1983), African Americans are under-represented in the sample.

The hazard estimations are provided in Table (3.3). These estimates are from a parametric hazard estimation, assuming a constant baseline hazard, per the parametric assumptions of the model (i.e., that p does not change over the duration of the unemployment spell). These are the coefficients that will be used to construct the individual-specific employment hazards in the GMM estimation. The estimates are typical of the unemployment literature—the coefficients on age, education and the African-American dummy are negative, thus decreasing the probability of re-employment. Having a spouse in the household who works decreases the probability of re-employment. The coefficients on number of dependents, the married dummy, and number of weeks on previous job are all positive. Only the African-American and married dummies and weeks in previous job are statistically significantly different from zero.

The empirical survival function is presented in Figure 3.4. Its smooth, downward slope is consistent with an exponential survivor function, the parametric assumption made on the employment hazard.

3.3.2 A Simple Estimation Procedure

For a simple initial procedure, β was identified using equation (3.17) with the estimated $\widehat{p_i}$ from the hazard estimation; λ is set to one. Average wage and benefit level were used; the productivity of a match was calculated by dividing the wage by the labor share of the US. Here, I used the standard .67. δ was calculated from the average p_i, and the average unemployment rates of Missouri and Pennsylvania from 1979-81 for this time, weighted by population. Unfortunately, the annual unemployment rates for these states at these times vary, per a business cycle downturn. The average unemployment over this period was 7.34%. The unemployment levels increased between 1979 and 1980, but stayed constant between 1980 and 1981. These latter two years is when many of these unemployed started to look for work. (The earliest observations have benefits start late 1979.)

The Nash bargaining estimates, provided in Table 3.4 are lower for this estimation than the calibration for the US above. Per the discussion of in the calibration section, this is likely because of the higher unemployment rate in this time period, than for the calibration exercise, which is based on the year 2002.

3.4 Conclusion

This chapter constructs a model with implications replacement rate optimality. From these optimality conditions, I estimate parameters of the model—in particular, the Nash bargaining weight for the worker. Cross-country calibration matches one of the few estimations of the Nash bargaining weight, for France. Variance in US employment hazards according to observable characteristics, not used for calculation of UI benefits, are used to estimate the Nash bargaining weight via GMM.

Future extensions will allow for a more sophisticated GMM procedure, allowing for estimation of other parameters (e.g., the CRRA coefficint), and incorporate more of the rich set of data available from the Upjohn Institute.

Table 3.1: Calibrated Nash Bargaining Weights, by Country

Country	$\widehat{\rho}$	Avg. Wage	Unemp.	s^L	β_C^1	$\beta_C^{1.5}$	β_1	ρ
Australia	32	36,3380	6.4	65.9	0.6309	0.6329	0.3940	0.9864
Belgium	66	34,6910	7.3	67.7	0.5613	0.5625	0.3762	0.9920
Canada	64	31,6270	7.7	73.6	0.5343	0.5360	0.3686	0.9883
Denmark	59	36,1920	4.6	66.0	0.7796	0.7806	0.4349	0.9918
Finland	64	28,6370	9.1	67.8	0.4462	0.4474	0.3434	0.9911
France	71	24,4180	8.9	69.3	0.4574	0.4585	0.3469	0.9921
Germany	61	34,3260	8.7	66.5	0.4694	0.4707	0.3504	0.9911
Greece	46	16,8140	10.0	70.7	0.4003	0.4022	0.3280	0.9848
Ireland	29	25,4270	4.3	76.9	0.8087	0.8115	0.4429	0.9763
Italy	52	25,9520	9.0	69.9	0.4530	0.4547	0.3452	0.9871
Japan	63	29,6050	5.4	70.6	0.7117	0.7130	0.4156	0.9905
Netherlands	71	33,2030	2.7	68.9	0.9287	0.9291	0.4967	0.9936
Portugal	78	12,7750	5.0	76.5	0.7453	0.7464	0.4250	0.9920
Spain	70	22,0250	11.3	71.8	0.3408	0.3420	0.3064	0.9898
United Kingdom	45	31,8310	5.1	76.7	0.7397	0.7422	0.4226	0.9810
United States	56	32,3600	5.8	75.0	0.6796	0.6817	0.4067	0.9856
$\delta = 0.0035$, $r = .0055$								

Table 3.2: Sample Means

Variable	Mean	Standard Deviation	Min	Max
Age	36.16691	13.54362	1	79
Base Income	3321.259	1907.502	0	19303
Replacement Rate	0.4660421	0.1550094	.0776801	3.148148
Yrs. Education	11.50519	1.976167	2	17
No. Dependents	0.9861728	1.256134	0	8
1=Black	0.0474074	0.2125612	0	1
1=Married	0.6474074	0.4778952	0	1
Weeks Unemployed	15.13037	14.81603	1	80
Weeks in Prev. Job	30.82222	16.95705	0	222
1=Spouse Works	0.4103704	0.4920224	0	1
$N = 2025$				

Table 3.3: Hazard Estimation

Variable	Coef.	Std. Err.	z	$P > \|z\|$
Age	-.0010355	.0018564	-0.56	0.577
Yrs. Educ	-.0065146	.0118219	-0.55	0.582
No. Depend.	.009289	.0191878	0.48	0.628
1=Black	-.2557928	.1069428	-2.39	0.017
1=Married	.1475432	.0653164	2.26	0.024
Weeks in Pre. Job	.0150137	.0006102	24.61	0.000
1=Spouse Works	-.0029573	.0561383	-0.05	0.958
Constant	-3.060832	.1757327	-17.42	0.000
$N = 2025$				

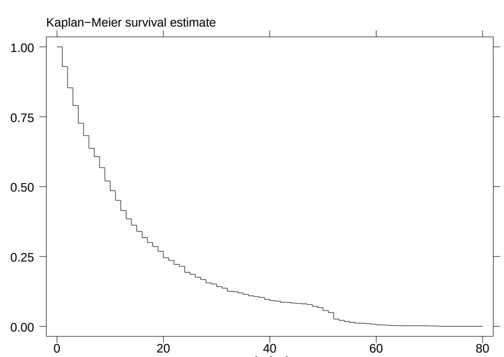


Table 3.4: GMM Estimates for β, by CRRA Coefficient

σ	1	1.5	2	2.5
$\widehat{\beta}$	.5760	.5780	.5800	.5821
$V(\widehat{\beta})$	.0040	.0040	.0040	.0040

Bibliography

Abbring, Jaap H., James J. Heckman, Pierre-Andre Chiappori, and Jean Pinquet, "Adverse Selection and Moral Hazard In Insurance: Can Dynamic Data Help to Distinguish?," *Journal of the European Economic Association*, 04/05 2003, *1* (2-3), 512–521.

Abowd, John and Laurence Allain, "Compensation Structure and Product Market Competition," Technical Report 5493, NBER 1996.

Adda, Jerome and Russell W. Cooper, *Dynamic Economics: Quantitative Methods and Applications*, MIT Press, 2003.

Bassi, Laurie J. and Stephen A. Woodbury, eds, *Research in Employment Policy: Reform of the Unemployment Insurance System*, Vol. 1, JAI Press Inc., 1998.

Cahuc, Pierre, Christian Gianella, Dominique Goux, and Andr Zylberberg, "Equalizing Wage Differences and Bargaining Power: Evidence from a Panel of French Firms," Technical Report, Institute for the Study of Labor (IZA) September 2002.

Cahuc, Pierre, Fabien Postel-Vinay, and Jean-Marc Robin, "Wage Bargaining with On-the-Job Search: Theory and Evidence," *Econometrica*, 03 2006, *74* (2), 323–364.

Casella, George and Roger L. Berger, *Statistical Inference*, 2 ed., Pacific Grove, CA: Duxbury, 2002.

Cohen, Alma and Liran Einav, "Estimating Risk Preferences from Deductible Choice," NBER Working Papers 11461, National Bureau of Economic Research, Inc July 2005.

Cooper, Russell W., *Coordination Games*, 1 ed., New York: Cambridge University Press, 1999.

Cutler, David and Richard Zeckhauser, "Adverse Selection in Health Insurance," *Forum for Health Economics & Policy*, 1998, *1* (1), 1056–1056.

Cutler, David and Richard Zeckhauser, *Handbook of Health Economics*, Vol. 1, Elsevier Science B.V., 2000.

Cutler, David M., "Employee Costs and the Decline in Health Insurance Coverage," NBER Working Papers 9036, National Bureau of Economic Research, Inc July 2002.

Cutler, David M., *Your Money or Your Life: Strong Medicine for America's Health Care System*, New York: Oxford University Press, 2004.

Feenberg, Daniel Richard and Elizabeth Coutts, "An Introduction to the TAXSIM Model," *Journal of Policy Analysis and Management*, Winter 1993, *12* (1), 189–194.

Feldstein, Martin S., "The Error of Forecast in Econometric Models when the Forecast-Period Exogenous Variables are Stochastic," *Econometrica*, 1971, *39* (1), 55–60.

Flinn, Christopher J., "Minimum Wage Effects on Labor Market Outcomes under

Search, Matching, and Endogenous Contact Rates," *Econometrica*, 07 2006, *74* (4), 1013–1062.

Fudenberg, Drew and Jean Tirole, *Tirole*, Cambridge, MA: MIT Press, 1991.

Gruber, Jonathan, "The Consumption Smoothing Benefits of Unemployment Insurance," NBER Working Papers 4750, National Bureau of Economic Research, Inc May 1994.

Gruber, Jonathan and James Poterba, "Tax Incentives and the Decision to Purchase Health Insurance: Evidence from the Self-Employed," *The Quarterly Journal of Economics*, August 1994, *109* (3), 701–33.

Gruber, Jonathan and James Poterba, "Tax Incentives and the Decision to Purchase Health Insurance: Evidence from the Self-Employed," *The Quarterly Journal of Economics*, 1994, *109* (3), 701–33.

Hamermesh, Daniel S., "Changing Inequality In Markets For Workplace Amenities," *The Quarterly Journal of Economics*, November 1999, *114* (4), 1085–1123.

Harris, Carl M., "The Pareto Distribution as a Queue Service Discipline," *Operations Research*, Mar.-Apr. 1968, *16* (2), 307–313.

Jacoby, Melissa B., Teresa A. Sullivan, and Elizabeth Warren, "Rethinking the Debates Over Health Care Financing: Evidence from the Bankruptcy Courts," *New York University Law Review*, May 2001, *76* (2), 375–418.

Johnson, Norman L., Samuel Kotz, and N. Balakrishnan, *Continuous Univariate Distributions*, 2 ed., Vol. 1, New York: John Wiley and Sons, Inc., 1994.

Koch, Thomas G., "Estimating the Demand for Medical Insurance: Using the Theory of Equalizing Differences," 2005. Unpublished manuscript.

Kohlberg, Elon and Jean-Francois Mertens, "On the Strategic Stability of Equilibria," *Econometrica*, September 1986, *54* (5), 1003–37.

Livshits, Igor, James MacGee, and Michele Tertilt, "Accounting for the Rise in Consumer Bankruptcies," 2006. Unpublished manuscript.

Ljungqvist, Lars and Thomas Sargent, "The European Unemployment Dilemma," *Journal of Political Economy*, June 1998, *106* (3), 514–550. 1998.

M., K. Frick Chernew and C. McLaughlin, "The Demand for Health Insurance Coverage by Low-Income Workers: Can Reduced Premiums Achieve Full Coverage?," *Health Services Research*, 1997, *32* (4), 453–470.

Martin, John P., "Measures of Replacement Rates for the Purpose of International Comparisons: A Note," *OECD Economic Studies*, 1996, (26), 99–115.

Mas-Colell, Andreu, Michael D. Whinston, and Jerry R. Green, *Microeconomic Theory*, New York: Oxford University Press, 1995.

Meyer, Bruce D., "Unemployment Insurance and Unemployment Spells," *Econometrica*, July 1990, *58* (4), 757–82.

NBER, "TAXSIM," 2006.

OECD, *Benefits and Wages*, OECD, 2004.

Office, General Accounting, "Emergency Care: EMTALA Implementation and Enforcement Issues," Report to Congressional Committees GAO-01-747, United States General Accounting Office June 2001.

Olson, Craig, "Do Workers Accept Lower Wages in Exchange for Health Benefits?," *Journal of Labor Economics,*, 2002, *20* (2).

Pratt, J.W., "Risk aversion in the small and in the large," *Econometrica*, 1964, *32*, 122–136.

Rosen, Sherwin, *Handbook of Labor Economics*, Vol. 1 of *Handbooks in Economics*, Elsevier Science, 1986.

Selten, Richard, "Re-examination of the perfectness concept for equilibrium points in extensive games," *International Journal of Game Theory*, 1975, (4), 25–55.

Sullivan, Teresa A., Elizabeth Warren, and Jay Lawrence Westbrook, *The Fragile Middle Class*, 1 ed., New Haven: Yale University Press, 2000.

Upjohn Institute, "An Analysis of UI Recipients' Unemployment Spells," Technical Report, W.E. Upjohn Institute for Employment Research 1983.

Woodbury, Stephen A and Daniel S Hamermesh, "Taxes, Fringe Benefits and Faculty," *The Review of Economics and Statistics*, 1992, *74* (2), 287–96.

Woodridge, Jeffrey M., *Econometric Analysis of Cross Section and Panel Data*, first ed., MIT Press, 2002.

Vita

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