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Welfare costs of reclassification risk in the health insurance market

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Abstract

One of the major problems of the U.S. health insurance market is that it leaves individuals exposed to reclassification risk. Reclassification risk arises because the health conditions of individuals evolve over time, while a typical health insurance contract only lasts for one year. A change in the health status can lead to a significant change in the health insurance premium. We study how costly this reclassification risk is for the welfare of consumers. More specifically, we use a general equilibrium model to quantify the implications of introducing guaranteed renewable contracts into the economy calibrated to replicate the key features of the health insurance system in the U.S. Guaranteed renewable contracts are private insurance contracts that can provide protection against reclassification risk even in the absence of consumer commitment or government intervention. We find that though guaranteed renewable contracts provide a good insurance against reclassification risk, the welfare effects from introducing this type of contracts are small. In other words, the presence of reclassification risk does not impose large welfare losses on consumers. This happens because some institutional features in the current U.S. system substitute for the missing explicit contracts that insure reclassification risk. In particular, a good protection against reclassification risk is provided through employer-sponsored health insurance and government means-tested transfers.

Keywords: health insurance, reclassification risk, dynamic insurance, guaranteed renewable contracts, general equilibrium

JEL Classification Codes: D52, D58, D91, G22, I11

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1 Introduction

An important feature of the health insurance market is that a typical insurance policy only lasts for one year while a disease can last for any period of time. This creates the problem of reclassification risk - a risk to face a drastic increase in health premiums when one's health status deteriorates. The fact that standard health insurance contracts leave individuals exposed to reclassification risk is considered an important market failure in the health insurance market (Hendel and Lizzeri, 2003; Diamond, 1992). The goal of this paper is to evaluate how important is the lack of protection against reclassification risk for the welfare of consumers.

One way to do this is to compare the current system with the first best solution to the problem of reclassification risk. The first best is to enroll everyone into a long-term health insurance contract. The price of such a contract depends on the average expected medical expenses of all participants. In other words, healthy people make transfers to the sick equalizing the insurance price for all risk categories. These contracts require consumer's commitment because healthy individuals will tend to drop out. As shown by Cochrane (1995), the lack of commitment can be overcome by introducing a special arrangement such as illiquid accounts[1]. Another problem with ensuring participation in these contracts is incomplete labor markets. Since premiums are based on average medical expenses but not on individual income, consumers experiencing a sequence of bad income shocks may be unable to pay the premium. This can be solved by introducing income-based transfers. However, since all income redistributive measures have a non-trivial effect on welfare, in the presence of these transfers it is hard to measure a pure welfare effect of reclassification risk.

To overcome this problem, we consider a special type of contract that can provide insurance against reclassification risk but does not require commitment, income-based transfers or any other special arrangements. These are guaranteed renewable contracts discussed in details by Pauly et al (1995). These contracts are front-loaded: a consumer is required to prepay part of his future premiums and this prepayment locks him into the contract. In return, a consumer is guaranteed that i) he will be able to renew his health insurance contract in the future; ii) the renewal price will be independent of his future health realizations. A key feature of this contract is that reclassification risk is insured not by making healthy people pay for the sick but by allowing individuals to make state-contingent savings that pay off when their premiums increase. To evaluate welfare costs of reclassification risk, we consider how much welfare improvement can be achieved from introducing guaranteed renewable contracts in the individual health insurance market.

[1] More specifically, Cochrane's idea is to substitute long-term contracts with a sequence of short-term contracts that require consumers who turn out to be healthy to make transfers to insurance firms. Illiquid accounts are needed to enforce these transfers.

We construct a general equilibrium overlapping generations model where people face uninsurable labor income risk and medical expense risk that can be partially insured. Several types of health insurance are available. First, some individuals have access to employer-based insurance. Second, lowest-income individuals can get Medicaid. Finally, all individuals can buy insurance policy directly in the individual market. In the individual market premiums are risk-rated, i.e. depend on the current health conditions of individuals. All policies last for one year while medical expenditures are persistent, which creates the problem of reclassification risk.

Our model reflects two institutional features that are important when evaluating the importance of reclassification risk in the U.S. health insurance markets. First, a large fraction of non-elderly adults gets their insurance from employer-based market. This market is community rated, i.e. premiums are independent of the health conditions of individuals. People with permanent access to this market are protected from the risk of premium fluctuations. Also, lowest-income individuals can get public insurance from Medicaid for free. Second, for people who face high medical shock and/or bad labor income shock, the government provides protection in the form of the consumption minimum floor. This consumption floor can also mitigate the consequences of the lack of an explicit insurance against reclassification risk.

We calibrate the model using the Medical Expenditure Panel Survey dataset to match the key insurance statistics for the U.S. Using the calibrated model we study the quantitative implications of introducing guaranteed renewable contracts in the individual market.

We find that comparing to the situation when only standard short-term insurance contracts are available, introduction of guaranteed renewable contracts can noticeably decrease uninsurance rates - from 25.9% to 19.4% due to the higher participation in the individual insurance market. Also, if both standard and guaranteed renewable contracts are available, most of the consumers prefer to buy the later type of contract. Our results show that people who hold guaranteed renewable contracts face almost no fluctuations in their health insurance premiums even if their health deteriorates. This implies that these contracts provide a good protection against reclassification risk.

In terms of welfare, we find that introduction of guaranteed renewable contracts brings only small welfare gains. This suggests that in the current U.S. health insurance system people are not very concerned about the absence of an explicit insurance against reclassification risk. This happens because two institutional features provide good implicit insurance against reclassification risk. First, employer-sponsored health insurance that protects mostly high-income people; and second, the consumption minimum floor that protects mostly people with low income. If these two institutional features are removed, the average welfare gains from having access to guaranteed renewable contracts are large and can exceed 2% of the annual consumption. Our results are robust to the alternative design of guaranteed renewable contracts and the degree of actuarial unfairness in the health insurance market.

This paper is structured as follows. Section 2 reviews the related literature. Section 3 illustrates how a guaranteed renewable contract works using a simple example. Section 4 presents the model. Section 5 explains our calibration. Section 6 discusses the results. Section 7 considers implications of our results for the upcoming health insurance reform. Section 8 concludes.

2 Related literature

This paper belongs to two strands of literature. First is the literature studying how private markets can provide insurance against reclassification risk if buyers cannot commit to a contract. A seminal paper in this area is Cochrane (1995) who characterizes a set of contracts that can provide long-term health insurance in such an environment. His insight is to combine standard one-period insurance contracts with premium insurance, i.e. insurance against future premium fluctuations. One requirement for such premium insurance to work is that each consumer needs to open a special account that works as a clearing house between him and the insurance company. An important condition is that consumers cannot freely withdraw money from this account. One special case in this set of contracts that can work without a special account are front-loaded guaranteed renewable contracts. These contracts were studied in more details by Pauly et al (1995) who showed that guaranteed renewable contracts can provide a good degree of reclassification risk insurance without creating liquidity problem if consumers buy them while still young and healthy. Front-loaded contracts were also studied by Hendel and Lizzeri (2003) for the case of life insurance market. They showed that the structure of premiums in this market is consistent with front-loaded contracts that emerge in the absence of consumer commitment. However, Fang and Kung (2010) and Daily et al (2008) showed that the growing life settlement market can limit the degree of reclassification risk insurance that life insurers can provide. Finkelstein et al. (2005) studied front-loaded contracts in the long-term care insurance market and showed that the amount of front-loading currently existing is not enough to lock consumers into the contracts. To our knowledge, our paper is the first one that studies welfare effects of guaranteed renewable contracts in the health insurance market in a general equilibrium framework.

The second strand of literature this paper belongs to studies quantitative heterogeneous agent models with incomplete markets augmented by (i) medical expense shocks and (ii) health insurance markets where these shocks can be partially insured. This branch of incomplete market literature has emerged recently and includes, among others, papers by Kitao and Jeske (2009) who study subsidies for employer-based insurance, Feng (2009) who investigates alternative ways to reform the U.S. health insurance system, Hsu (2009) who studies the effect of private health insurance on savings, and Pashchenko and Porapakkarm (2010) who study the current health reform in the U.S. These studies consider an environment when only standard one-period contracts are available in the individual health insurance market. Our contribution to this literature is to allow both standard and guaranteed renewable contracts to be offered in the market.

3 Simple illustration

This section constructs a simple example that illustrates how a guaranteed renewable contract works. Consider an individual whose health is good, and the price he pays for a standard one-period health insurance contract is p_L. With probability v an individual may still be in good health in the next period, in which case his health insurance premium will stay unchanged. However, with probability $1-v$ his health status may deteriorate. If this happens, his health insurance premium for the standard contract will raise to p_H, where $p_H > p_L$. If an individual buys the standard one-period contract, he is exposed to reclassification risk - the risk that his health premium will rise from p_L to p_H.

Suppose an individual has an option to buy a guaranteed renewable contract at the price p_1^{GR}. This contract insures his medical expenditure in the next period like the standard one-period contract. On top of that, it guarantees that in the next period an individual can buy health insurance at the prespecified price p_2^{GR} *that does not depend on his health status realization*. If his health status remains the same he can buy a standard contract at price p_L. However, if his health status deteriorates he can renew his guaranteed renewable contract at price $p_2^{GR} < p_H$. Under the assumption of perfect competition in the insurance market, the price of such a guaranteed renewable contract is determined in the following way:

$$p_1^{GR} = p_L + (1-v)(p_H - p_2^{GR}). \tag{1}$$

Note that the guaranteed renewable contract is more expensive than the regular one-period contract because of the front-loading part $(1-v)(p_H - p_2^{GR})$. This front-loading takes into account the fact that an individual can become unhealthy but the price of renewing his health insurance (p_2^{GR}) cannot be readjusted.

4 Model

4.1 Households

Demographics and preferences

The economy is populated by two overlapping generations: young and old. A young individual stays young with probability ζ^y and becomes old with a probability $1-\zeta^y$. An old individual survives to the next period with probability ζ^o[2]. The population is assumed to remain constant. Old agents who die are replaced by the entry of new young agents.

An individual discounts his future utility by the discount factor β. Preferences are described by the CRRA utility function with the risk aversion parameter σ:

$$u(c) = \frac{c^{1-\sigma}}{1-\sigma}.$$

Health insurance

An individual's health status h is indexed by $\{1, 2, .., H\}$. An increasing number implies deteriorating health status. Health status evolves according to a H-state Markov process, where $G^y(h'|h)$ stands for the young and $G^o(h'|h)$ for the old. The current health status of an individual determines his current medical expenditures $x(h)$, where x is a deterministic and strictly monotone-increasing function, different between the young and the old. Thus, in the following, we will refer to health status (h) and medical expenditures (x) interchangeably.

Each young individual can buy insurance against medical expenditures in the individual insurance market where two types of contracts are offered. The first type is a standard one-year contract that covers some fraction of the next period medical expenditures. The price of this contract depends on the current health status of an individual and is denoted by $p^I(h)$. The second type of contract is guaranteed renewable. This contract covers a fraction of the next period's medical expenditures like a standard one-year contract. In addition, a guaranteed renewable contract provides an option to renew insurance in the following period at the same price regardless of the new health status[3]. Guaranteed renewable contracts do not have a termination date, i.e. an individual can

[2]We assume a stochastic aging environment because it greatly simplifies our computation. The most time-consuming part of our computations is to find equilibrium prices of guaranteed renewable contracts. In a stochastic aging model this price depends only on health status. In the full life-cycle model the price will be a function of both age and health.

[3]There are several ways to design a guaranteed renewable contract by changing the price that an insurer guarantees at the renewal. In our main experiments we assume that the renewal price is the same as the price of the original contract. Later on we relax this assumption by letting the renewal price to differ from the original price. Detailed discussion of these experiments is provided in section 6.

renew the same contract as long as he is still young. An important condition for an individual to be able to renew this contract is continuous participation. In other words, if an individual does not renew the contract once, he will loose the option to renew it in the future. The premium of a *newly issued* guaranteed renewable contract is a function of the *current* health status of an individual. The price of a guaranteed renewable contract that is already *in force* is fixed and determined by the health status of an individual *at the time of the contract initiation.*

In each period, with some probability, a young individual can get an offer to buy employer-sponsored health insurance (ESHI). This is denoted by g: $g = 1$ if an individual gets an ESHI offer, $g = 0$ if he does not. The out-of-pocket premium of employer-based insurance is equal to

$$\overline{p} = (1 - \psi)\, p.$$

Here p is the premium charged to all participants of the employer-based pool, and ψ is the fraction of this premium paid by the employer.

Low-income individuals are eligible to enroll in Medicaid that provides health insurance for free. To become eligible for Medicaid, an individual's total resources net of out-of-pocket medical expenses must be below a certain level which is denoted by y^{pub}.[4]

We use i to index the current health insurance status as follows:

$$i = \left\{ \begin{array}{lll} -2 & ; & \text{if uninsured} \\ -1 & ; & \text{if insured by Mediciad} \\ 0 & ; & \text{if holding a standard one-period insurance or ESHI} \\ 1, 2, ..., H & ; & \text{if holding a guaranteed renewable contract originated when} \\ & & \text{his health status equals } i. \end{array} \right\}$$

If an individual holds a guaranteed renewable contract, i keeps track of the health status when the contract was initiated. For a newly purchased contract i is the current health status h. We denote the premium for a newly issued guaranteed renewable insurance as $p^{GR}(h)$, and the premium for a guaranteed renewable contract that is already in force as $p^{GR}(i)$ for $i = \{1, 2, ..., H\}$.

If a young person is insured, the insurance will cover a fraction $q(i, x)$ of his current medical expenses. This fraction depends on his medical expenditures (x) and the type of insurance he has (i).

All retired households are enrolled in Medicare. Medicare charges a premium of p^{med}. We denote the fraction of medical expenses covered by Medicare by $q^{med}(x)$.

[4]Most of U.S. states (35) operate medically needy programs. When determining Medicaid eligibility these programs take into consideration not the total income but the income net of medical expenditures.

Labor income

A young individual supplies labor inelastically. We denote his earnings by $\widetilde{w}z$, where $\widetilde{w}$ is the adjusted wage per effective labor unit and z is his idiosyncratic productivity. We model the productivity, an ESHI offer, and health status as a joint Markov process. The productivity of the old is set to zero.

Taxation and social transfers

Each households has to pay income tax $\mathcal{T}(y)$. The taxable income y is based on both labor income and capital income. We incorporate two features of the current U.S. tax code related to the taxation of health-related expenses into our definition of y. First, households can tax-exempt their medical expenses in excess of 7.5% of their income. Second, households buying group insurance can subtract the out-of-pocket group premium $\overline{p}$ from their taxable income.

We also assume a social welfare system, T^{SI}. The social welfare system guarantees that a household will have a minimum consumption level at $\underline{c}$. This reflects the U.S. public transfer programs such as food stamps, Supplemental Security Income (SSI), and transfers to finance uncompensated care[5].

All old individuals are retired. They receive Social Security benefits in the amount ss.

Optimization problem

Retired individuals The state variables of an old individual include liquid capital ($k \in \mathbb{K} = R^{+} \cup \{0\}$) and health status ($h \in \mathbb{H} = \{1, 2, ..., H\}$). The value function of the old can be written as follows:

$$\mathbf{V}^{o}(k,h) = \max_{c,k'} \quad u(c) + \beta \zeta^{o} E_t \mathbf{V}^{o}(k',h') \tag{2}$$

$$s.t. \qquad k(1+r) + ss + T^{SI} = c + \zeta^{o} k' + x\left(1 - q^{med}(x)\right) + p^{med} + \mathcal{T}(y) \tag{3}$$

where

$$T^{SI} = \max\left(0, \underline{c} + x\left(1 - q^{med}(x)\right) + \mathcal{T}(y) + p^{med} - ss - k(1+r)\right) \tag{4}$$

$$y = \max(0, \widetilde{y}) \tag{5}$$

$$\widetilde{y} = rk + ss - \max\left(0, x\left(1 - q^{med}(x)\right) - 0.075(rk + ss)\right) \tag{6}$$

[5]Kaiser (2004) estimates that in 2004 85% of uncompensated care were paid by the government. The major portion is through disproportionate share hospital (DSH) payment.

Equation (3) is the budget constraint. We assume that there is an actuarially-fair annuity market. Thus each retired individual needs to save only $\zeta^o k'$ instead of k'[6]. Equation (6) takes into account the tax-deductibility of medical expenses in excess of 7.5% of the total income.[7]

Young individuals The state variables for a young individual include liquid capital ($k \in \mathbb{K} = R^+ \cup \{0\}$), health status ($h \in \mathbb{H} = \{1, 2, ..., H\}$), idiosyncratic labor productivity ($z \in \mathbb{Z} = R^+$), ESHI offer status ($g \in \mathbb{G} = \{0, 1\}$), and index of health insurance status ($i \in \mathbb{I} = \{-2, -1, 0, 1, 2, ..., H\}$).

Each period an individual chooses his consumption (c), saving (k'), and health insurance status for the next period $\left(i^H\right)$. Depending on one's Medicaid eligibility, ESHI offer and insurance status, he can choose not to buy any insurance (NB), buy a guaranteed renewable contract (BGR), renew the existing guaranteed renewable contract (RGR), buy a standard individual policy (BI), buy a group insurance (BG), or enroll in Medicaid (BM). We summarize the insurance choices as follows.

- If a household currently has a guaranteed renewable contract, $i = \{1, 2, 3, .., H\}$,[8]

$$i^H = \begin{array}{ll} \{BGR, RGR, BI, BG, BM\} & \text{if } g = 1 \text{ and eligible for Medicaid} \\ \{BGR, RGR, BI, BM\} & \text{if } g = 0 \text{ and eligible for Medicaid} \\ \{NB, BGR, RGR, BI, BG\} & \text{if } g = 1 \text{ and not eligible for Medicaid} \\ \{NB, BGR, RGR, BI\} & \text{if } g = 0 \text{ and not eligible for Medicaid} \end{array}$$

- If a household does not have a guaranteed renewable contract, $i = \{-2, -1, 0\}$,

$$i^H = \begin{array}{ll} \{BGR, BI, BG, BM\} & \text{if } g = 1 \text{ and eligible for Medicaid} \\ \{BGR, BI, BM\} & \text{if } g = 0 \text{ and eligible for Medicaid} \\ \{NB, BGR, BI, BG\} & \text{if } g = 1 \text{ and not eligible for Medicaid} \\ \{NB, BGR, BI\} & \text{if } g = 0 \text{ and not eligible for Medicaid} \end{array}$$

The value function of a working-age household can be written as follows:

$$\mathbf{V}^y(k, h, z, g, i) = \max_{c,k',i^H} u(c) + \beta\zeta^y E\mathbf{V}^y(k', h', z', g', i') + \beta(1 - \zeta^y)E\mathbf{V}^o(k', h', i') \qquad (7)$$

$$s.t. \qquad k(1 + r) + \widetilde{w}z + T^{SI} = c + k' + x(1 - q(i, x)) + P\left(h, i, i^H\right) + \mathcal{T}(y) \qquad (8)$$

[6]Alternatively, one can assume that the accidental bequests are evenly distributed to all young. Since the distributed amount is small, it will not affect our results. But the computational cost is higher since one needs to wait until the convergence of total bequests to get the invariant distribution.

[7]The problem of a newly retired household is slightly different from a retired household since he is still covered by his pre-retirement insurance. The difference lies in the state variables and the out-of-pocket medical expenditure. For the newly retired, the state variables are $\{k, h, i\}$; and in the budget constraint $x\left(1 - q^{med}(x)\right)$ is replaced by $x(1 - q(i, x))$.

[8]Note, that if a household is eligible for Medicaid he cannot stay uninsured because Medicaid is free.

where

$$\widetilde{w}=\left\{\begin{array}{lll} w & ; & \text{if } g=0 \\ w-c_E & ; & \text{if } g=1 \end{array}\right\} \tag{9}$$

$$P\left(h,i,i^H\right)=\left\{\begin{array}{lll} 0 & ; & \text{if } i^H=NB \text{ or } BM \\ p^I\left(h\right) & ; & \text{if } i^H=BI \\ p^{GR}\left(h\right) & ; & \text{if } i^H=BGR \\ p^{GR}\left(i\right) & ; & \text{if } i^H=RGR \\ \overline{p} & ; & \text{if } \ i^H=BG \end{array}\right\} \tag{10}$$

$$y=\max\left(0,\widetilde{y}\right) \tag{11}$$

$$\widetilde{y}=\left\{\begin{array}{lll} \widetilde{w}z+rk-\max\left(0,x\left(1-q\left(i,x\right)\right)-0.075\left(\widetilde{w}z+rk\right)\right) & ; & \text{if } i^H\neq BG \\ \widetilde{w}z+rk-\max\left(0,x\left(1-q\left(i,x\right)\right)-0.075\left(\widetilde{w}z+rk\right)\right)-\overline{p} & ; & \text{if } i^H=BG \end{array}\right\} \tag{12}$$

$$T^{SI}=\max\left(0,\underline{c}+x\left(1-q\left(i,x\right)\right)+\mathcal{T}\left(y\right)-\widetilde{w}z-k\left(1+r\right)\right) \tag{13}$$

$$i'=\left\{\begin{array}{lll} -2 & ; & \text{if } i^H=NB \\ -1 & ; & \text{if } i^H=BM \\ 0 & ; & \text{if } i^H=\{BI,BG\} \\ i & ; & \text{if } i^H=RGR \\ h & ; & \text{if } i^H=BGR \end{array}\right\} \tag{14}$$

The conditional expectation on the right-hand side of equation (7) is over $\{h',z',g'\}$. The second equation is the budget constraint. In equation 9, w is the wage per effective labor unit. If a household has an ESHI offer, then the employer partly pays for the premium. In order to break even, the employer deducts c_E from the wage per effective labor unit to get an adjusted wage $\widetilde{w}$. Equation (12) reflects the tax deductibility of the ESHI premium and medical expenses exceeding 7.5% of the income. Equation (14) maps the current health insurance status and health insurance choices into the next period health insurance status. The income eligibility of Medicaid program requires that

$$k\left(1+r\right)+\widetilde{w}z-x\left(1-q\left(i,x\right)\right)\leq y^{pub}.$$

Distribution of households To simplify the notations, we denote the space of a household' state variables by $\mathbb{S}$: $\mathbb{S}\equiv\mathbb{K}\times\mathbb{H}\times\mathbb{Z}\times\mathbb{G}\times\mathbb{I}$ for young individuals, $\mathbb{S}\equiv\mathbb{K}\times\mathbb{H}\times\mathbb{I}$ for just-retired individuals, and $\mathbb{S}\equiv\mathbb{K}\times\mathbb{H}$ for retirees. Let $\mathbf{s}\in\mathbb{S}$ and denote by $\Gamma^y\left(\mathbf{s}\right)$ and $\Gamma^o\left(\mathbf{s}\right)$ the measure of young and retired people correspondingly.

4.2 Production sector

There are two stand-in firms that act competitively. Their production functions are Cobb-Douglas, $AK^\alpha L^{1-\alpha}$, where K and L are aggregate capital and aggregate labor and

A is the total factor productivity. The first stand-in firm offers ESHI to its workers. The second stand-in firm does not[9]. Under the competitive market assumption, the second firm pays each employee his marginal product of labor. Because capital is freely allocated between the two firms, the Cobb-Douglas production function implies that the capital-labor ratios of both firms are the same. Consequently we have[10]

$$r = \alpha A K^{\alpha-1} L^{1-\alpha} - \delta, \tag{15}$$

$$w = (1-\alpha) A K^{\alpha} L^{-\alpha} \tag{16}$$

where δ is the depreciation rate.

The first firm has to partially finance health insurance premiums for its employees. These costs are fully passed on to the employees through a wage reduction. In specifying this wage reduction we follow Jeske and Kitao (2009). The first firm subtracts an amount of c_E from the marginal product per effective labor. The total wage reduction of each employee with an ESHI offer is $c_E z$[11]. The zero profit condition implies

$$c_E = \frac{\psi p \left(\int \mathbf{1}_{\{i^H = BG\}} \Gamma^y(\boldsymbol{s}) \right)}{\int \mathbf{1}_{\{g=1\}} z \Gamma^y(\boldsymbol{s})}. \tag{17}$$

where $\mathbf{1}_{\{\cdot\}}$ is a function that is equal to one if its argument is true, otherwise the function is equal to zero.

4.3 Private health insurance sector

We model the health insurance sector under the following assumptions. First, both individual and group insurance markets are competitive implying zero expected profit for each insurance contract. Second, there are administrative costs associated with issuing an insurance policy and these costs are proportional to the total value of the contract. Third,

[9] An alternative setup is that there are two islands, one offers ESHI and the other does not. Workers are stochastically allocated between the two islands but there are no frictions in the capital market. Inside each island, the labor market is competitive.

[10] Define $\{K_1, L_1\}$ and $\{K_2, L_2\}$ as aggregate capital and labor in firms 1 and 2. Since capital can move freely between firms, the Cobb-Douglas production implies $r + \delta = \alpha A \left(\frac{K_1}{L_1}\right)^{\alpha-1} = \alpha A \left(\frac{K_2}{L_2}\right)^{\alpha-1}$. Next we can write

$$\frac{K}{L} = \frac{K_1 + K_2}{L_1 + L_2} = \frac{\frac{K_1}{L_1} + \frac{K_2}{L_2}\frac{L_2}{L_1}}{1 + \frac{L_2}{L_1}} = \frac{K_1}{L_1}.$$

The last equality uses the fact that $\frac{K_1}{L_1} = \frac{K_2}{L_2}$.

[11] The assumed structure implies a proportional transfer from high-income to low-income people inside the employer-based pool. This assumption is not important for our results since all changes in our study happen in the individual insurance market. An alternative assumption is a lump-sum wage reduction. This alternative structure is difficult to implement in our setup since some workers will end up earning zero or negative wage.

health insurance companies can observe only the current health status of an individual.[12]

Standard one-period insurance

The zero profit condition implies that the premium for a standard one-period insurance contract is equal to the expected discounted medical costs covered by an insurance company multiplied by administrative load $\left(\gamma^I\right)$:

$$p^I\left(h\right)=\left(1+r\right)^{-1}\gamma^I EM\left(h\right) \tag{18}$$

Here $EM\left(h\right)$ is the expected medical expenses of an individual with health status h covered by an insurance company:

$$EM\left(h\right)=\sum_{h'}x\left(h'\right)q\left(0,x\left(h'\right)\right)G^y(h'|h)$$

Guaranteed renewable insurance

The price of a newly issued guaranteed renewable contract depends on the current health status of an individual. To determine the premium, an insurer needs to assign a probability to an event that an individual will continue to renew the contract. Consider an individual with health status h_t who chooses to buy a new guaranteed renewable contract in period t. Denote by $\pi_{t+j}\left(h_{t+j}|h_t\right)$ an insurer's belief that this individual will continue to renew the same insurance contract every period up to a period $t+j$ when his health status becomes h_{t+j}. The zero profit condition allows us to write the premium of a new guaranteed renewable contract as follows:

$$p^{GR}\left(h_t\right)=p^I\left(h_t\right)+\sum_{j=1}^{\infty}\frac{1}{\left(1+r\right)^j}\sum_{h_{t+j}=1}^{H}\pi_{t+j}\left(h_{t+j}|h_t\right)\left(p^I\left(h_{t+j}\right)-p^{GR}\left(h_t\right)\right) \tag{19}$$

The first term on the right hand side is the premium for a standard insurance contract that covers medical expenses in the next period. The second term is the extra payment for the option to renew the contract in the future. It arises because an insurance company will not be able to readjust the price in the future even if an individual's health deteriorates.

The beliefs of the insurer $\pi_{t+j}\left(h_{t+j}|h_t\right)$ should be consistent with households' optimal decisions in equilibrium. Denote the measure of young people with health status h_t who choose to buy a new guaranteed renewable contract in period t by $\Gamma^y\left(h_t, i_t^H=BGR\right)$.

[12] For standard one-period insurance contracts only health status matters for pricing. For guaranteed renewable contracts an additional factor that affects pricing is the probability that the contract will be renewed in the future. This probability depends not only on health, but also on other state variables, in particular assets and labor income. We do not allow prices to be conditioned on assets or labor income because these variables are difficult for insurance companies to verify.

Denote by $\mathcal{F}\left(h_{t+j}, i_{t+j}^{H} = RGR || h_t, i_t^{H} = BGR\right)$ the measure of those people in this group who have been renewing the same contract every period from period t to period $t+j$ when their health become h_{t+j}. Thus $\pi_{t+j}\left(h_{t+j}|h_t\right)$ can be defined as

$$\pi_{t+j}\left(h_{t+j}|h_t\right) = \frac{\mathcal{F}\left(h_{t+j}, i_{t+j}^{H} = RGR || h_t, i_t^{H} = BGR\right)}{\Gamma^y\left(h_t, i_t^{H} = BGR\right)} \tag{20}$$

Employer-based group insurance

The premium in the group insurance market does not depend on the health status of individuals[13]. Using the zero profit condition, the premium can be written as a weighted average of the expected covered medical costs of participating employees multiplied by the administrative load $\left(\gamma^G\right)$.

$$p = (1+r)^{-1}\gamma^G \frac{\int \mathbf{1}_{\{i^H = BG\}} \times EM\left(h\right)\Gamma^y\left(\boldsymbol{s}\right)}{\int \mathbf{1}_{\{i^H = BG\}}\Gamma^y\left(\boldsymbol{s}\right)}, \tag{21}$$

4.4 Government constraint

We assume that the government runs a balanced budget. This implies:

$$\int \mathcal{T}\left(y\right)\Gamma^y\left(\boldsymbol{s}\right) + \int \mathcal{T}\left(y\right)\Gamma^o\left(\boldsymbol{s}\right) = \int \left(ss + xq^{med}\left(x\right) - p^{med}\right)\Gamma^o\left(\boldsymbol{s}\right) + \int T^{SI}\Gamma^y\left(\boldsymbol{s}\right) + \int T^{SI}\Gamma^o\left(\boldsymbol{s}\right) \tag{22}$$

The left-hand side is the total income tax. The first term on the right-hand side is the net expenditure on Social Security and Medicare systems for the old. The last two terms are the costs of running the means-tested transfer program, i.e. to keep households above the consumption minimum floor.

4.5 Competitive equilibrium with asymmetric information[14]

Given the government programs $\left\{\underline{c}, ss, q^{med}\left(x\right), p^{med}\right\}$, the insurance coverage $\left\{q\left(i,x\right)\right\}$, and the fraction of the group premium contributed by the employer (ψ), the competitive equilibrium with asymmetric information consists of the set of equilibrium prices $\left\{w, r, p, p^I\left(h\right), p^{GR}\left(i\right)\right\}$, wage reduction $\left\{c_E\right\}$, households' value functions $\left\{\mathbf{V}^y\left(\boldsymbol{s}\right), \mathbf{V}^o\left(\mathbf{s}\right)\right\}$, decision rules for the young $\left\{c\left(\boldsymbol{s}\right), k'\left(\boldsymbol{s}\right), i^H\left(\boldsymbol{s}\right)\right\}$ and for the old $\left\{c\left(\boldsymbol{s}\right), k'\left(\boldsymbol{s}\right)\right\}$, the tax function $\left\{\mathcal{T}\left(y\right)\right\}$, time-invariant distributions $\left\{\Gamma^y\left(\mathbf{s}\right), \Gamma^o\left(\mathbf{s}\right)\right\}$, and the set of insurers' beliefs $\left\{\pi_{t+j}\left(h_{t+j}|h_t\right); j > 0, \forall t\right\}$ such that the following conditions are satisfied:

[13]The U.S. regulation prohibits employers to charge employees with different health-related characteristics different insurance premiums.

[14]We refer to this equilibrium as asymmetric information equilibrium because insurance companies observe only one state variable - health status. For guaranteed renewable contracts health is not the only variable relevant for pricing which creates an asymmetric information environment.

1. Given the set of prices and the tax function, decision rules and value functions solve the individuals' optimization problems (2) and (7).

2. Wage (w) and rent (r) satisfy Equations (15) and (16).

3. Labor market clears: $L = \int z\Gamma^y(\boldsymbol{s})$

4. Capital market clears. Since guaranteed renewable contracts are front-loaded, there will be a balance carrying over time for each contract. We need to take this balance into account when computing the aggregate capital. Denote by $\theta^t_{t+j}(h_t)$ an ex-post balance at time $t+j$ of a unit of contract sold at time t to an individual with health status h_t. One period after a contract is originated this balance takes the following form:

$$\begin{aligned}\theta^t_{t+1}(h_t) &= p^{GR}(h_t)(1+r) - \gamma^I EM(h_t) + \\ & p^{GR}(h_t)\int\limits_{h_{t+1}} \frac{\mathcal{F}\left(h_{t+1}, i^H_{t+1} = RGR||h_t, i^H_t = BGR\right)}{\Gamma^y\left(h_t, i^H_t = BGR\right)}.\end{aligned}$$

The first term on the right-hand side is the premium collected at the initiation of the contract and carried on to the next period. The second term is the cost of medical claims in period $t+1$. The last term is the revenue from the contract renewal. We can define recursively the ex-post balance j periods after the contract is originated as follows[15]:

$$\begin{gathered}\theta^t_{t+j}(h_t) = \theta^t_{t+j-1}(h_t)(1+r) - \\ \gamma^I \int\limits_{h_{t+j-1}} EM(h_{t+j-1}) \frac{\mathcal{F}\left(h_{t+j-1}, i^H_{t+j-1} = RGR||h_t, i^H_t = BGR\right)}{\Gamma^y\left(h_t, i^H_t = BGR\right)} + \\ p^{GR}(h_t)\int\limits_{h_{t+j}} \frac{F\left(h_{t+j}, i^H_{t+j} = RGR||h_t, i^H_t = BGR\right)}{\Gamma^y\left(h_t, i^H_t = BGR\right)}.\end{gathered}$$

Thus the capital market clearing condition in period t can be written as

$$\begin{gathered}K = \int k'(\mathbf{s})\Gamma^y(\mathbf{s}) + \int k'(\mathbf{s})\Gamma^o(\mathbf{s}) + \\ p\int \mathbf{1}_{\{i^H(\mathbf{s})=BG\}}\Gamma^y(\mathbf{s}) + \int \mathbf{1}_{\{i^H(\mathbf{s})=BI\}} p^I(h)\Gamma^y(\mathbf{s}) + \\ \int \mathbf{1}_{\{i^H(\mathbf{s})=BGR\}} p^{GR}(h)\Gamma^y(\mathbf{s}) + \sum_{j=1}^{\infty}\int \theta^{t-j}_t(h_{t-j})\Gamma^y\left(h_{t-j}, i^H_t(\mathbf{s}) = BGR\right)\end{gathered}$$

5. c_E satisfies Equation (17); thus the firm offering ESHI earns zero profit.

[15] By recursively substituting θ^t_{t+j-1}, this equation is equivalent to Equation (19).

6. The tax function $\{\mathcal{T}(y)\}$ satisfies the government budget balance in Equation (22).

7. Standard one-period insurance premiums, $p^I(h)$, satisfy Equation (18), guaranteed renewable premiums $p^{GR}(i)$, $i = 1, ..., H$, satisfy Equation (19), and the group insurance premium (p) satisfies Equation (21). Thus health insurance companies earn zero expected profit on each contract.

8. Insurance companies' beliefs $\{\pi_{t+j}(h_{t+j,t}|h_t); j > 0, \forall t\}$ satisfy Equation (20) if $\Gamma^y\left(h_t, i_t^H = BGR\right) \neq 0$. Otherwise,

$$\pi_{t+j}(h_{t+j}|h_t) = 0 \quad ; \qquad j > 0, \forall t. \tag{23}$$

The last equation is the off-equilibrium belief of insurers. When no one with health status h_t buys a guaranteed renewable contract, insurers believe that if one with health h_t buys a guaranteed renewable contract, he will not renew the contract in the next period[16].

5 Data and Calibration

5.1 Data

We calibrated the model using the Medical Expenditure Panel Survey (MEPS) dataset. The MEPS collects detailed records on demographics, income, medical costs and insurance for a nationally representative sample of households. It consists of two-year overlapping panels and covers the period of 1996-2006. We use eight waves of the MEPS, from 1999 to 2007[17].

The MEPS links people into one household based on eligibility for coverage under a typical family insurance plan. This Health Insurance Eligibility Unit (HIEU) defined in the MEPS dataset corresponds to our definition of a household. All statistics we use were computed for the head of the HIEU. We define the head as the person who has the highest income in the HIEU. A different definition of the head (based on gender) does not give significantly different results. We use longitudinal weights provided in the MEPS to compute all the statistics. Given that all individuals are observed for at most two years, we pool together all eight waves of the MEPS. Since each wave is a representation of the population in each year, the weight of each individual was divided by eight in the pooled sample.

In our sample we include all non-student heads whose age is at least 20 and whose labor income (to be defined later) is non-negative. The sample size for each wave is

[16] Our results are robust to an alternative specification of the off-equilibrium beliefs.

[17] We do not use the first two waves of the MEPS because they do not contain the variables we use for constructing a household unit.

presented in Table 1. We use 2003 as a base year. All level variables were normalized to the base year using the Consumer Price Index (CPI).

Panel	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	Total
Obs.	4,954	4,017	8,248	6,244	6,464	6,417	6,200	6,656	49,200

Table 1: Number of observations in eight waves of MEPS (1999-2007)

When measuring the insurance status in the data, we use the following approach. In the MEPS the question about the source of insurance coverage is asked retrospectively for each month of the year. We define a person as having employer-based insurance if he reports having ESHI for at least eight months during the year (variables PEGJA-PEGDE). The same criteria was used when defining public insurance (variables PUBJA-PUBDE) and individual insurance status (variables PRIJA-PRIDE)[18]. In addition, we assume that a person has an ESHI offer if he reports having an offer in at least two out of three interview rounds during a year (variables OFFER31x, OFFER42x, OFFER53x).

5.2 Demographics, preferences and technology

The period in the model is one year. Young agents are born at age 20 and stay young on average 45 years, so the probability to stay young, ζ^y, is set to 44/45. The survival probability of an old individual ζ^o is set to make the fraction of the old in the population equal to 20%; thus $1-\zeta^o = 4\left(1-\zeta^y\right)$. To keep the total measure of population equal to one, the measure of newborns in every period is set to $\frac{\left(1-\zeta^y\right)\left(1-\zeta^o\right)}{2-\zeta^y-\zeta^o}$.

The risk aversion parameter σ is equal to 3 which is in the range commonly used in the macroeconomic literature. The discount factor β is calibrated to match the aggregate capital output ratio of 3.0.

The Cobb-Douglas function parameter α is set to 0.33 which corresponds to the U.S.'s capital income share. The annual depreciation rate δ is calibrated to achieve the interest rate of 4.0% in the baseline economy. The total factor productivity A is normalized to make the average labor income equal to one in the baseline model.

[18]For those few individuals who switch the source of coverage during the year, we define insurance status in the following way. If a person has both ESHI and individual insurance in one year, and each coverage lasted for less than eight months but with a total duration of coverage of more than eight months, we classify this person as individually insured. Likewise, when a person has a combination of individual and public coverage that altogether lasts for more than eight months, we define that individual as having public insurance. Our results do not change significantly if we change the cutoff point to 6 or 12 months.

5.3 Joint process of health, labor income, and ESHI offer

Health status and Medical expenses

The medical expenses in our model correspond to the total amount paid for the health care services (variable: TOTEXP). This includes both out-of-pocket payments and payments made by insurance companies but it does not include over-the-counter drugs. In our model there is a one-to-one mapping between medical expenses and health status. We categorize medical expenses into five bins and each bin corresponds to a different health status (Table 2).

	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$
medical expenses (percentile)	$< 30^{th}$	$30^{th} - 60^{th}$	$60^{th} - 90^{th}$	$90^{th} - 99^{th}$	$> 99^{th}$

Table 2: Health status and medical expenses

The average amount of medical expenses corresponding to each health status are (0.001,0.016,0.075, 0.318,1.483) for young households and (0.021,0.083,0.251,0.917,2.317) for retired households. These numbers are based on the medical expenses in 2003/2004 wave normalized by the average labor income ($\$35,624$).

To construct a transition matrix for health status, we compute the fraction of household moving from one bin to another. The resulting transition matrix for young households, $G^y(h'|h)$, is

0.619	0.264	0.092	0.022	0.002
0.261	0.432	0.260	0.044	0.003
0.094	0.257	0.517	0.122	0.010
0.070	0.142	0.414	0.341	0.034
0.013	0.096	0.274	0.372	0.245

,

while the transition matrix for retired households, $G^o(h'|h)$, is

0.626	0.225	0.111	0.037	0.001
0.257	0.416	0.265	0.058	0.005
0.131	0.324	0.427	0.108	0.011
0.090	0.170	0.455	0.242	0.043
0.056	0.174	0.388	0.336	0.046

.

Here the first row corresponds to $h=1$ and the first column corresponds to $h'=1$.

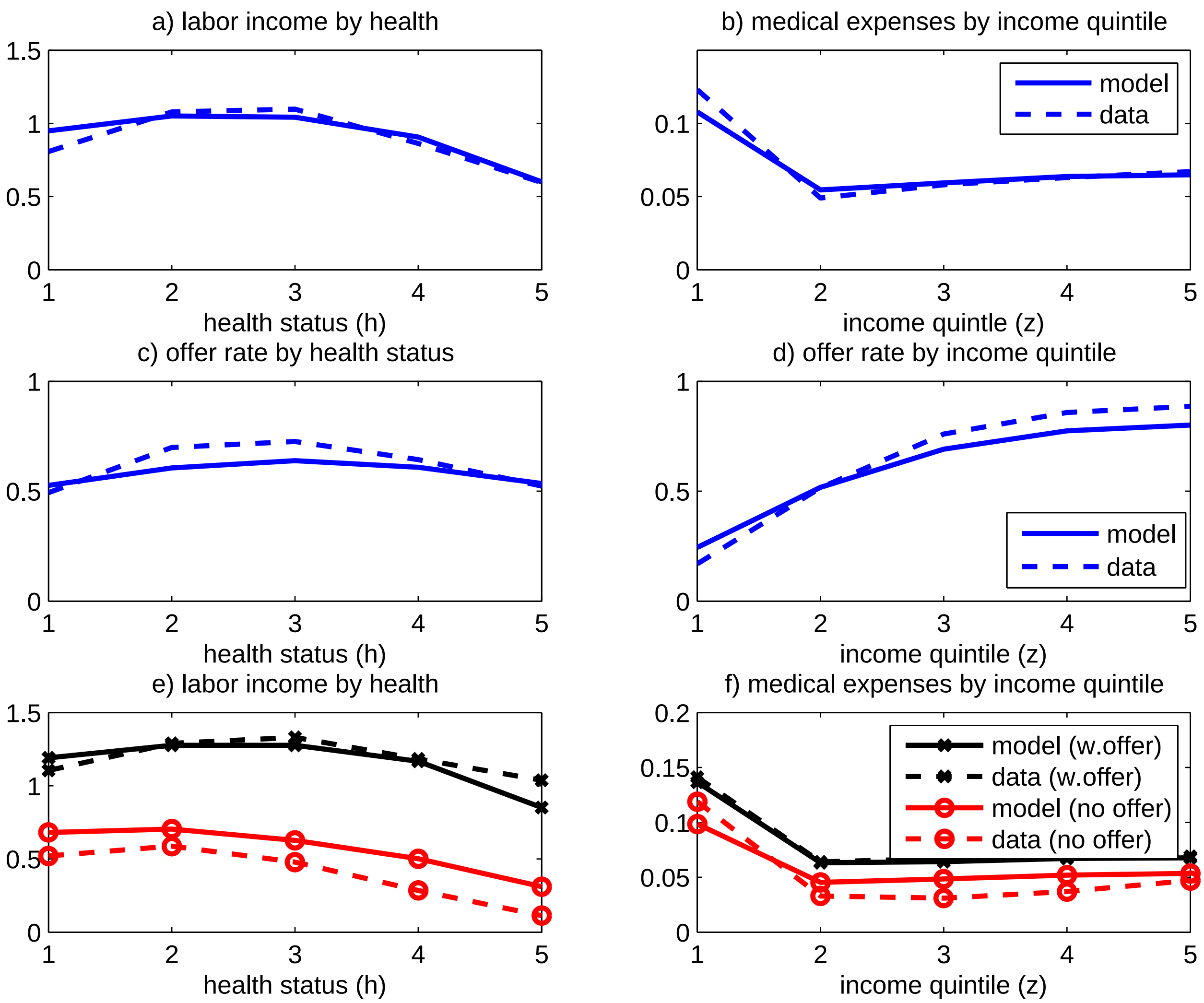

Figure 1: Relationship between ESHI offer, labor income, and medical expenses

Labor income

We define labor income as a sum of wages (variable WAGEP) and 75% of income from business (variable BUSNP). This definition is the same as used in the Panel Study of Income Dynamics Dataset (PSID) that has been commonly used for income calibration in the macroeconomic literature. We categorized labor income into five quintiles ($5 \times 20\%$). The labor income level in each quintile is based on the value for 2003/2004 wave normalized by the average income. These numbers are 0.091, 0.477, 0.802, 1.226, and 2.417.

The dashed lines in Panels (a) and (b) in Figure 1 show the relationship between labor income and medical expenses/health observed in the data. The hump shape in Panel (a) can be explained by the life-cycle profile of labor income. Our model does not have age dimension so the age profile of labor income is partially captured by health status. In the data households in good health ($h = 1$) are more likely to be young, while those in bad health ($h = 4$ or $h = 5$) are more likely to be near retirement. These two groups tend to have lower incomes than the middle-age households.

Panel (b) also shows that the average medical expenses of households in the first income quintile are two times higher than the average medical expenses of the high income group. This pattern is driven by two facts. First, the distribution of medical expenses is highly skewed: the medical expenses of people with $h = 5$ is more than four times higher than the medical expenses of those with $h = 4$. Second, households with serious health problems, $h = 5$, are more likely to experience a very low income shock.

When constructing a joint Markov process of labor income and health status, our goal is to capture the above pattern. To do this we divide our sample into four subsamples based on the health status in the *second* year of each wave. The first, second, and third subsamples include households whose health status in the second year equals 1, 2, and 3 respectively. The forth subsample include households whose health status in the second year equals 4 or 5. Then we construct a transition matrix of labor income for each subsample by calculating the fraction of households who move from one quintile to another. The resulting four transition matrixes capture the dynamics of labor income conditional on health shock in the second period, and are denoted as $Q(z'|z, h' = 1), Q(z'|z, h' = 2), Q(z'|z, h' = 3),$ and $Q(z'|z, h' = 4).$ Due to the small sample size, we cannot get the transition matrix conditional on $h' = 5$ directly. So we define

$$Q(z'|z, h' = 5) = a \times Q(z'|z, h' = 4) + (1 - a) \times D; \qquad 0 \leq a \leq 1,$$

where D is a 5×5 matrix with the first column equal to one and the remaining columns equal to zero. If $a = 1$, $Q(z'|z, h' = 5) = Q(z'|z, h' = 4)$. But if $a = 0$, $Q(z'|z, h' = 5) = D$, meaning that the income of those households who have serious health problems drops to the level of the lowest income quintile. In our calibration, we choose a to make the average labor income of those with $h = 5$ match the data as shown in Panel (a) of Figure 1.

The joint transition matrix of health status and labor income is constructed by combining the transition matrix of health status, $G^y(h'|h)$, with the conditional transition matrix of labor income $Q(z'|z, h')$. The advantage of this approach is that the conditional expected medical expenses depend only on the current health status. This dramatically simplifies the computation since we can compute the premiums of standard one-period insurance directly from $G^y(h'|h)$[19].

ESHI Offer status

The dashed line in Panel (d) in Figure 1 shows that there is a strong correlation between the probability to get access to ESHI and labor income. We assume that the probability of getting an ESHI offer is a logistic function:

$$Prob_t = \frac{\exp(u_t)}{1 + \exp(u_t)},$$

where the variable u_t is an odds ratio that takes the following form:

$$u_t = \eta_0 + \eta_1 D_{g_{t-1}} + \eta_h D_{h_t} + \eta_z D_{z_t} + \eta_{year} D_{year}, \tag{24}$$

where $D_{g_{t-1}}$ is a dummy variable for an ESHI offer in period $t-1$, D_{h_t} and D_{z_t} are the sets of dummy variables for health status and income quintile in period t, and D_{year} is a set of dummy variables for each year.

To calibrate the joint distribution $\{h, z, g\}$ of newborns, we use the empirical joint distribution of households aged 20-35 from the data.

Figure 1 allows to compare our simulations of $\{h, z, g\}$ with the data (simulations are plotted with the solid lines). Overall, we are able to match the key features of the data well. However, the simulated offer rate (59.1%) is slightly lower than in the data (64%)[20].

[19] If the conditional expected medical expense also depend on the current labor income, say $E(x'|x, z = 1) \neq E(x'|x, z = 2)$, and the insurance company does not observe z, then the premiums of standard one-period contracts will depend on households' insurance decision and the equilibrium distribution of households.

[20] This mismatch mostly arises from the absence of educational heterogeneity in our model. As shown in Pashchenko and Porapakkarm (2011), people with low educational attainment have a significantly lower probability to get access to ESHI.

5.4 Insurance policies

We use the MEPS to find the fraction of medical costs covered by an average insurance policy. We estimate the following equation

$$InsCov = \beta_0 + \beta_1 x + \beta_2 x^2 + \Theta D_{year}$$

separately for private insurance, Medicaid, and Medicare. $InsCov$ is medical expenses paid by insurance (variables: TOTPRV,TOTMCD,TOTMCR). We include only people with positive medical expenses when estimating this regression. Then we use our estimates to compute the fraction of medical expenses covered by insurance for each health status and truncate it to be between 0 and 1. Table 3 reports the results for each type of insurance.

	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$
Medicaid: $q(-1,x)$	1.00	1.00	0.70	0.52	0.50
Private insurance: $q(i,x)$ for $i=\{0,1,..,5\}$	0.00	0.40	0.71	0.78	0.81
Medicare: $q^{med}(x)$	0.00	0.35	0.56	0.64	0.65

Table 3: Fraction of medical expenses covered by insurance

5.5 Government constraint

In calibrating the tax function $\mathcal{T}(y)$ we use a nonlinear relationship specified and estimated by Gouveia and Strauss (1994):

$$\mathcal{T}(y) = a_0\left[y - \left(y^{-a_1} + a_2\right)^{-1/a_1}\right]$$

Here a_0 controls the marginal tax rate levied on people with the highest income, a_1 determines the progressivity of the tax code, and a_2 is a scaling parameter. We set a_0 and a_1 to the original estimates of Gouveia and Strauss (0.258 and 0.768 correspondingly). The parameter a_2 is used to balance the government budget.

The consumption minimum floor $\underline{c}$ in the baseline economy was calibrated so that the fraction of households with assets less than $\$5,000$ in the model is the same as in the data. Based on the 1989-2001 Survey of Consumer Finance (SCF) dataset this fraction is 20.0% (Kennickell, 2003). To match this fraction, $\underline{c}$ is set to 0.92 of the Federal Poverty Line (FPL), or $\$8,807$.

The Social Security replacement rate is set to 45% of the average labor income. This number is obtained by applying the Social Security benefit formula to the average labor earnings profile.

5.6 Medicaid and private insurance

The Medicaid eligibility rules differ from state to state. As of 2009, 14 states had an income eligibility threshold below 50% of FPL, 20 states had it between 50% and 99% of FPL, and 17 states had it higher than 100% of FPL (Kaiser Family Foundation, 2008). We set y^{pub} to 48.0% of FPL, or $4,595, to match the fraction of people insured by Medicaid.

In our baseline model, we assume that only standard one-year contracts are offered in the individual market. To match the fraction of those buying individual insurance, we set the administrative load of an individual insurance policy γ^I to 1.208.

The administrative load for the group insurance γ^G is set to 1.11 (Kahn et al, 2005). We set the share of health insurance premium paid by the firm (ψ) to 83.0%. This number is consistent with the data in which the premiums of group insurance paid by employers range from 77% to 89% (Sommers, 2002).

5.7 Performance of the baseline model

Tables 4 and 5 summarize the parameters used in our baseline model. Table 6 reports the fraction of non-elderly adults with different insurance statuses and the numerical results from the baseline model. The model slightly underestimates the fraction of people with ESHI because our calibrated offer rate is lower than that in the data. As a result the fraction of uninsured is slightly overestimated.

Parameter name	Notation	Value	Source
Risk aversion	σ	3	-
Cobb-Douglas parameter	α	0.33	Capital share in output
Tax function parameters	a_0	0.258	Gouveia and Strauss (1994)
	a_1	0.768	Gouveia and Strauss (1994)
Social Security replacement rates	ss	45%	-
Group insurance loads	γ^G	1.11	Kahn et all (2005)
Employer's contribution	ψ	0.83	Sommers (2002)
Medicare premium	p^{med}	$1,071	Total premiums =2.11% of Y

Table 4: Parameters set outside the model

To evaluate the performance of our baseline model, we use health insurance statistics not targeted by our calibration. Figures 2 and 3 show the decomposition of health insurance status along the dimension of labor income and health status. Our model is able to replicate the insurance statistics for people in different income and health categories.

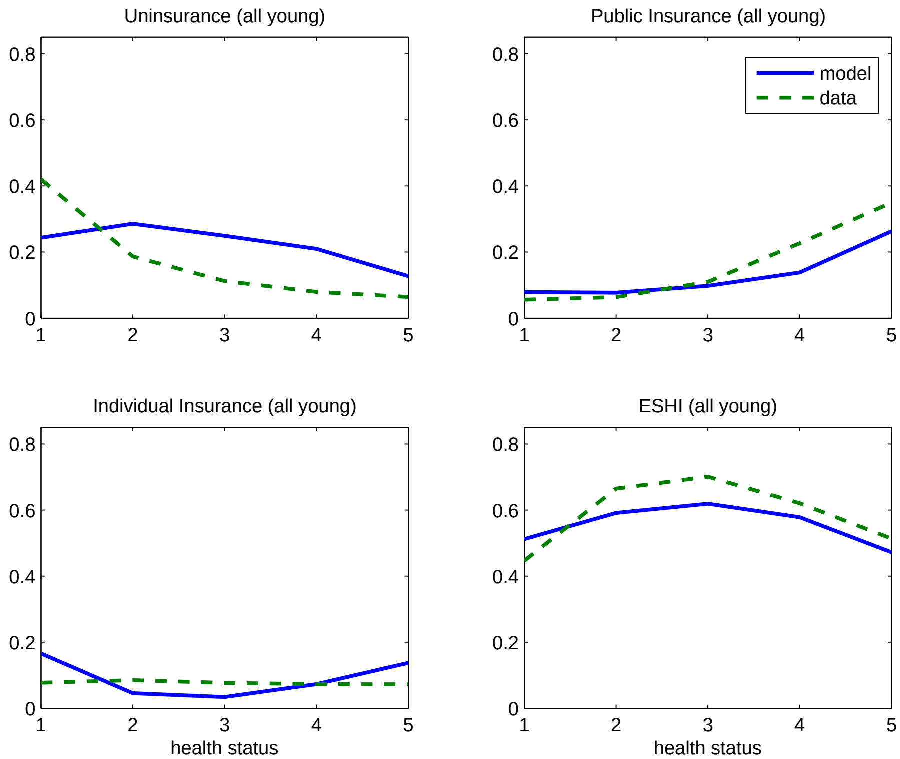

Figure 2: Insurance decision by health status (baseline model)

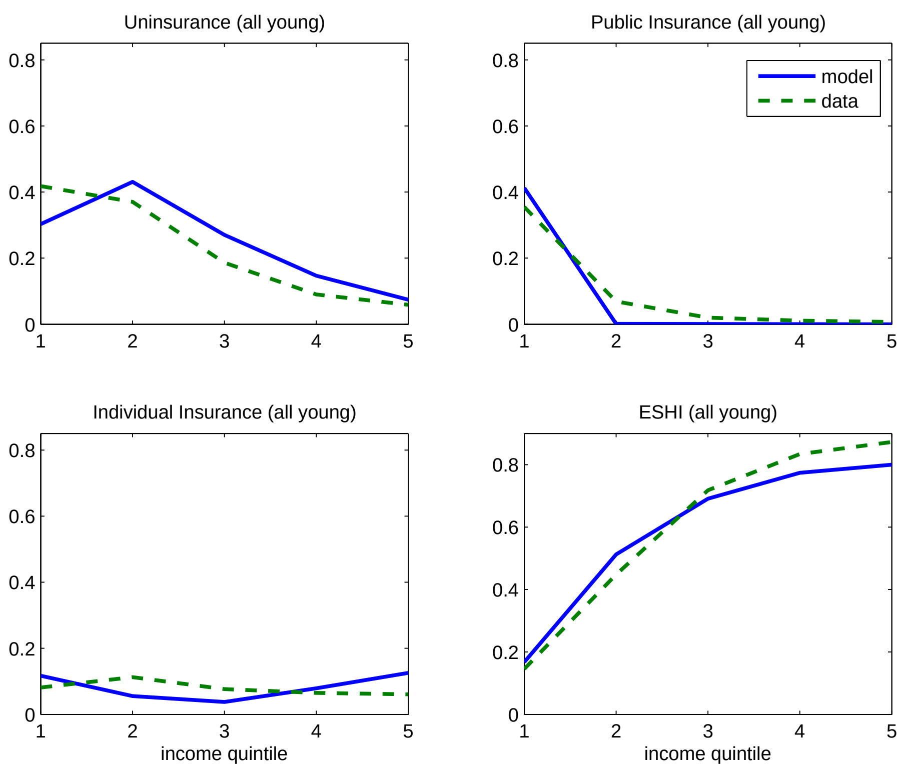

Figure 3: Insurance decision by labor income (baseline model)

Parameter name	Notation	Value	Target
Discount factor	β	0.908	$\frac{K}{Y}=3$
Depreciation rate	δ	0.07	$r=0.04$
Individual Insurance loads	γ^I	1.21	% of individual insurance=8.2%
Medicaid's income eligibility	y^{pub}	$4,595	% of public insurance=9.1%
Consumption floor	$\underline{c}$	$8,807	% with assets<$5,000=20%

Table 5: Parameters used to match some targets

	uninsured	public ins	individual ins	ESHI
data	21.45%	9.10%	8.20%	61.30%
model	25.4%	9.10%	8.20%	57.30%

Table 6: Percentage of non-elderly adults with different insurance status (2003/2004)

6 Results and discussions

This section discusses how the baseline economy changes once guaranteed renewable contracts are introduced. We provide analysis based on the open economy case, i.e. we fix the interest rate and the wage but allow all insurance prices to adjust in equilibrium[21].

6.1 Effects on premiums

Figure 4 compares the premium for a *newly issued* guaranteed renewable contract with that for a standard one in the new steady state. Guaranteed renewable contracts are more expensive due to the extra payment for the renewability. The difference in prices between the two types of contracts declines as health status deteriorates. For example, for the healthiest group the premium for a guaranteed renewable contract is almost three times higher than that for a standard contract. On the other extreme, for people in the worst health status, the premiums for guaranteed renewable and standard insurance are the same. For this group of people health status cannot deteriorate any further, so the price of a guaranteed renewable contract does not include the extra payment for renewability.

To understand how well guaranteed renewable contracts provide protection against reclassification risk, Figure 5 compares premiums for standard contracts with the average premiums for guaranteed renewable contracts including those that are already *in force for at least one period*. An important observation is that on average people who hold guaranteed renewable contracts face insurance premiums that are almost independent

[21] We do this to isolate the pure effect of providing insurance against reclassification risk from the effect of change in aggregate capital. For the closed economy case, the aggregate capital slightly decreases by 0.4%.

of their health status. This happens because most people initiate guaranteed renewable contracts when they are healthy and later they face low premiums even if their health becomes worse. In contrast, people who buy standard contracts face a steep increase in their premiums once their health status deteriorates. This implies that guaranteed renewable contract is a good means to eliminate the risk of premium fluctuations.

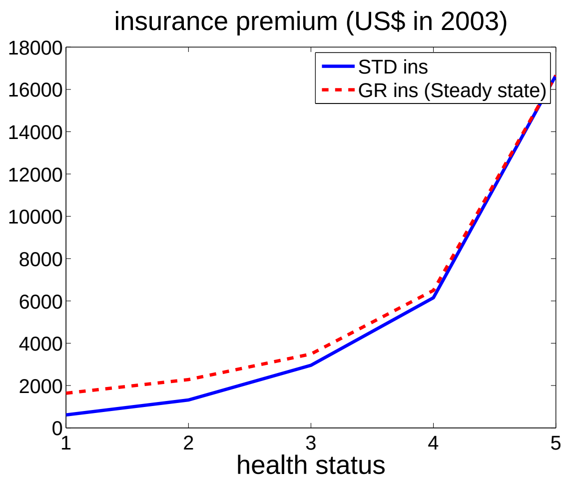

Figure 4: Premiums for new contracts

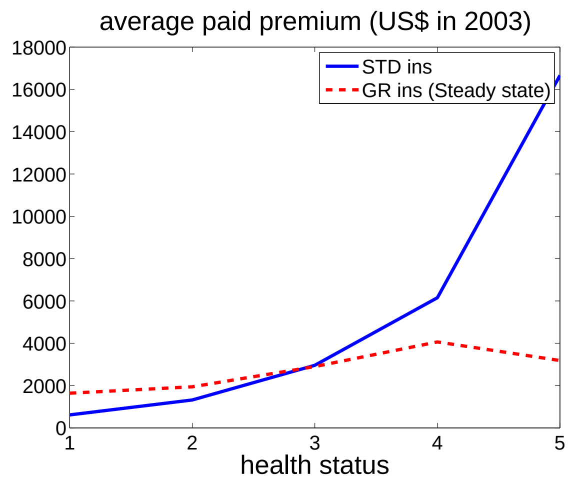

Figure 5: Average premiums for existing contracts

6.2 Effects on health insurance decisions

Table 7 shows how households' insurance purchasing decisions change after guaranteed renewable contracts are introduced. The fraction of uninsured in the new steady state noticeably decreases from 25.4% to 19.4%. The fraction of people with individual insurance increases from 8.2% to 14.2%, and most of this people (9.8%) hold guaranteed renewable contracts.

	Baseline	+GR contracts
Uninsured (%)	25.4	19.4
Individually insured (%)	8.2	14.2
- by standard contracts	8.2	4.4
- by GR contracts	–	9.8
Publicly insured (%)	9.1	9.1
Insured by ESHI (%)	57.3	57.3

Table 7: Insurance statistics before and after introduction of GR contracts (steady-state)

Table 8 shows how people move between different insurance statuses once guaranteed renewable contracts are available[22]. Around 19% of previously uninsured people start buying insurance once there is the option of guaranteed renewability. This suggests that guaranteed renewability makes the individual insurance market more attractive. Indeed, around 45% of people who were previously buying standard contracts switch to use guaranteed renewable ones.

		Insurance decisions if GR insurance is available				
		Uninsured	Medicaid	ESHI	Std ins	GR ins
Original decisions	Uninsured	80.7%	0.00%	0.00%	0.02%	19.26%
	Medicaid	0.00%	100.0%	0.00%	0.00%	0.00%
	ESHI	0.00%	0.00%	100.0%	0.00%	0.00%
	Std ins	0.60%	0.00%	0.00%	54.63%	44.76%

Table 8: Changes in insurance decisions if GR contracts are available

Figures 6 and 7 show the decomposition of health insurance decisions by income quintile and health status. Figure 6 shows that once guaranteed renewable contracts become available, the participation in the individual market increases for people both in good and bad health meaning that the risk-sharing increases. More specifically, the percentage of uninsured among people in the worst health status decreases from 12.7% to 9.3%, while for people in the best health status this number goes down from 24.3% to 22.4%. This can be explained by the fact that individuals buy guaranteed renewable insurance when they are still in good health and therefore are able to renew it at a relatively low premium once their health deteriorates. Table 9 illustrates this point further by showing that people buying guaranteed renewable contracts tend to have higher expected medical expenses than those buying standard contracts.

	Insurance	Average $E(x)$	Average labor inc	Average total inc
Baseline	Std ins	0.057	1.107	1.246
New steady-state	Std ins	0.038	1.326	1.433
with GR ins	GR ins	0.084	0.628	0.828

Table 9: Average income and medical expenses for people choosing different types of contracts

Figure 7 shows that guaranteed renewable contracts crowd out standard contracts and reduce the fraction of uninsured individuals for all income quintiles. Interestingly, people in the two lowest income quintiles show the largest participation in the market for guaranteed renewable contracts. Table 9 shows that on average individuals buying guaranteed renewable contracts have lower income than those buying standard contracts.

[22]This table is constructed for the first period of transition to the new steady-state once guaranteed renewable contracts are available.

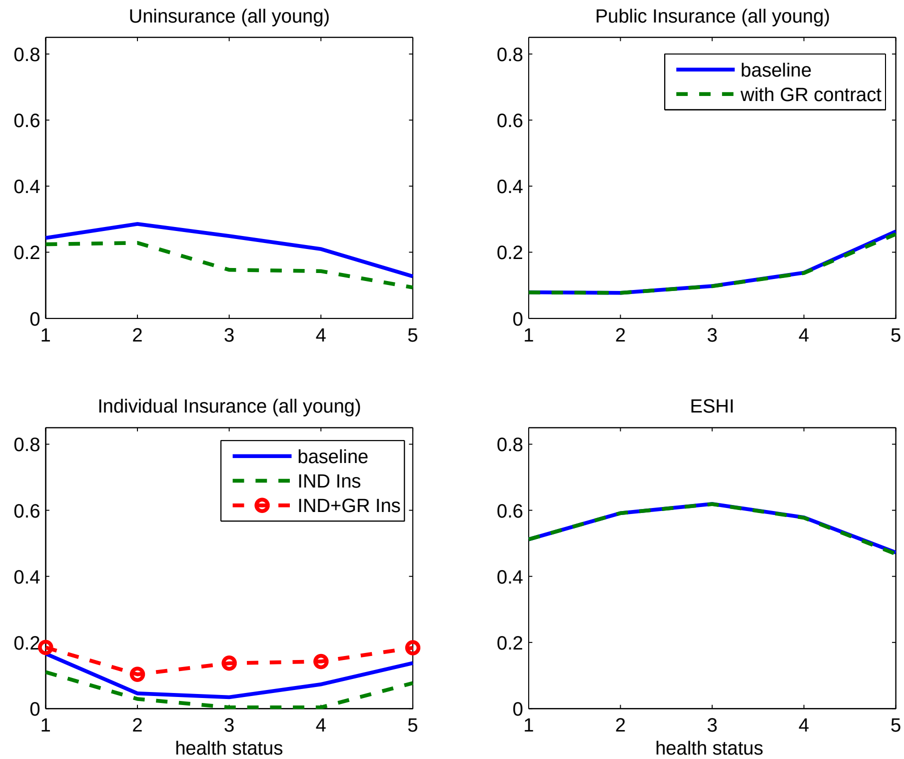

Figure 6: Insurance decisions by health status in the steady-state (+GR contract)

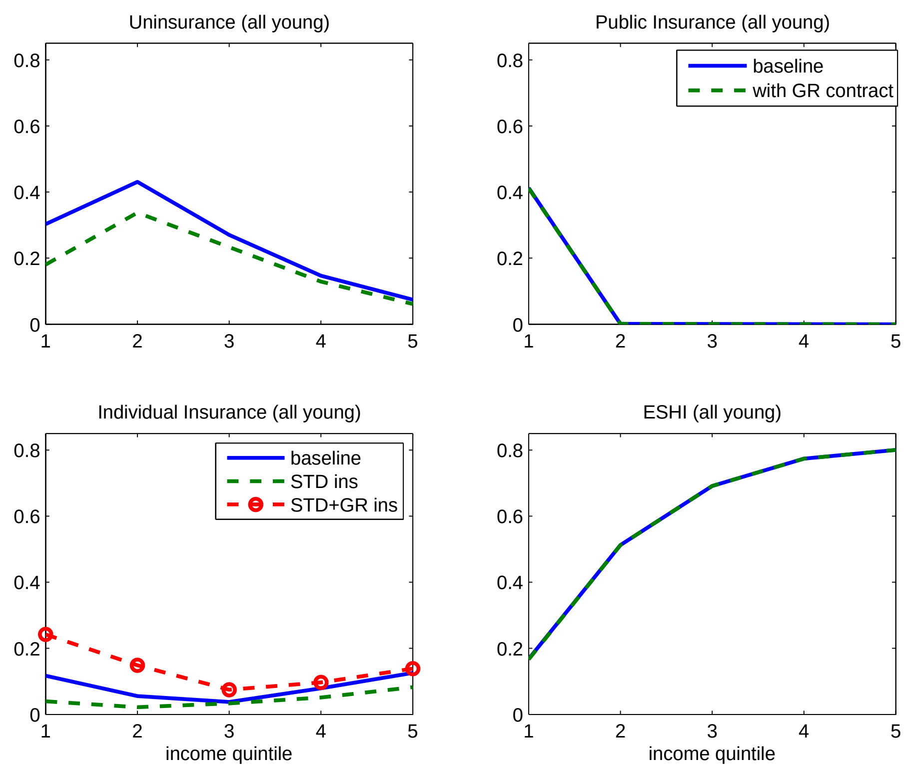

Figure 7: Insurance decisions by labor income in the steady-state (+GR contract)

This seems surprising at first given that guaranteed renewable contracts are more expensive than standard ones. To investigate this issue further, Figure 8 plots the fraction of people buying guaranteed renewable contracts in each asset and income quintiles. One can see that the negative correlation between income and demand for guaranteed renewable contracts comes from the top two asset quintiles. In other words, individuals who buy guaranteed renewable contracts have accumulated enough assets to afford this type of contract but their income is low. These individuals are less likely to get access to ESHI, and as will be shown later, this is an important factor determining the demand for guaranteed renewable contracts.

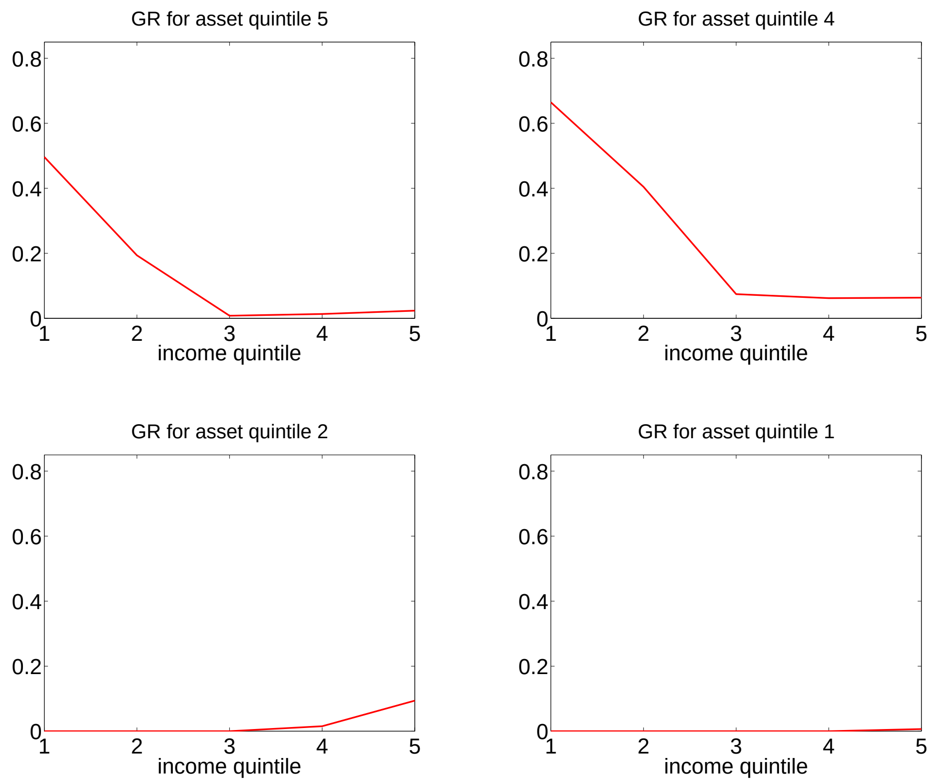

Figure 8: Fraction of people buying GR contracts by income and asset quintile

6.3 Welfare analysis

The first row of Table 10 illustrates the welfare gains when moving to an economy where guaranteed renewable contracts are available. Despite the fact that guaranteed renewable contracts provide good protection against reclassification risk, the resulting welfare gains are small. A newborn in the new economy needs a compensation equivalent to 0.0170% of his annual consumption if he is to live in the baseline economy. If we take transition periods into account, the average welfare gains among all young slightly increase to 0.0696%.

Experiments	average CEV	
	newborn	all young
Benchmark	0.0170%	0.0696%
Effect of Medicaid and ESHI		
- No Medicaid program	0.0171%	0.0715%
- No ESHI program	0.0537%	0.1774%
- No Medicaid and ESHI program	0.0542%	0.1812%
Effect of consumption floor		
- 0.75$\underline{c}$ ($6,605)	0.0269%	0.1862%
- 0.50$\underline{c}$ ($4,403)	0.0571%	0.4134%
- 0.25$\underline{c}$ ($2,201)	0.2136%	1.0319%
- 0.10$\underline{c}$ ($880)	0.8575%	2.3293%
Effect of front-loading		
- 125% of p^{GR}	0.0151%	0.0645%
- 180% of p^{GR}	0.0149%	0.0622%
Effect of labor income risk		
- reduced labor income risk	0.0303%	0.0244%
Effect of actuarial unfairness		
- No administrative load ($\gamma^{GR} = \gamma^{I} = 0$)	0.0150%	0.0905%

Table 10: Consumption equivalent variation after introducing GR contracts[a]

[a]The above welfare changes are computed by comparing two economies: an economy with a setup corresponding to each experiment and an economy with the same setup except having guaranteed renewable contracts. The CEV of newborns corresponds to the comparative statics between the two steady-states, while the CEV of all young takes into account the steady-state distribution in the baseline model and the transition periods.

Figure 9 shows that the consumption equivalent variation in the first period where guaranteed renewable contracts become available differs substantially by income and asset quintiles. People with low income but high assets are the ones who value guaranteed renewable contracts most. This is the same group that have the highest demand for guaranteed renewable insurance as shown in Figure 8.

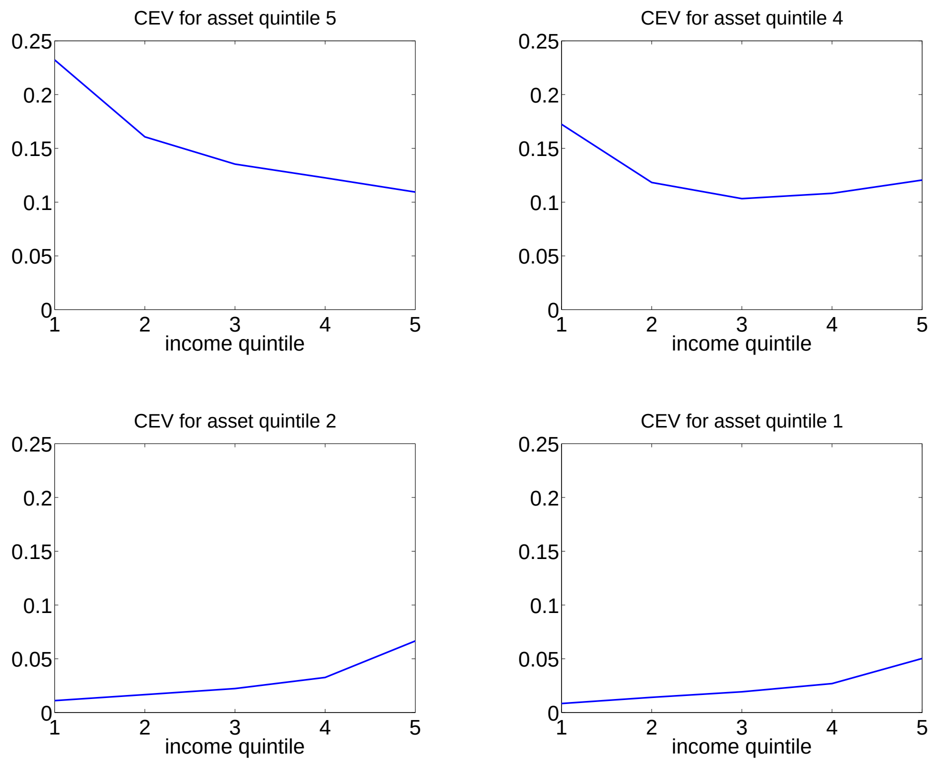

Figure 9: Consumption Equivalence by income and asset quintile (benchmark)

The small welfare gains from having an explicit insurance against reclassification risk imply that the effect of reclassification risk on consumption smoothing is not large. To investigate why this is the case, we consider several factors which may affect how much individuals are concerned about reclassification risk and how much they value the new insurance contracts. In particular, we consider the following six factors: i) implicit insurance against reclassification risk provided by ESHI and Medicaid, ii) the consumption minimum floor, iii) different degree of front-loading, v) labor income risk, and vi) actuarial unfairness of premiums. The first two factors affect how well individuals are protected against reclassification risk in the baseline economy. The last three factors affect individuals' valuation of guaranteed renewable contracts as a means to provide reclassification risk insurance.

In all experiments, when computing welfare gains for all young we control for the distribution of the households. In general, the distribution of households can change significantly from one experiment to the other. To make sure our comparisons are valid, we always compute the average welfare gains for all young using the same distribution. More specifically, in all experiments we use the steady-state distribution of the baseline economy as an initial distribution of the transition period.

ESHI and Medicaid

In the baseline economy there are two institutions that can provide an implicit insurance against reclassification risk. These institutions are Medicaid and employer-based insurance. Both Medicaid and ESHI provide health insurance at a risk-independent rate. Medicaid is free, and premiums for ESHI are community rated, i.e. they are the same for all participants in the employer-based pool. Thus, an agent with a high probability of getting access to these insurance schemes is less concerned about the risk that his premium will increase when his health deteriorates.

To understand how quantitatively important these effects are, we consider several counterfactual experiments. We remove ESHI, Medicaid or both of these programs from the baseline economy, and then reevaluate the welfare gains from introducing guaranteed renewable contracts. The results are presented in the third to fifth rows of Table 10. The corresponding changes in the individuals' insurance decisions are shown in the second and third rows of Table 11.

	uninsured	Std ins	GR ins	Pub ins	ESHI
Benchmark	19.4	4.4	9.8	9.1	57.3
No Medicaid	28.0	4.6	10.7	–	57.3
No ESHI	33.1	7.5	50.1	9.3	–
$0.75\underline{c}$ ($6,605)	12.0	6.2	17.4	6.6	57.8
$0.50\underline{c}$ ($4,403)	7.3	5.9	24.2	4.2	58.3
$0.25\underline{c}$ ($2,201)	3.3	4.7	30.9	2.9	58.2
$0.10\underline{c}$ ($880)	2.9	3.7	33.7	2.4	57.4
125% of p^{GR}	18.9	4.6	10.1	9.1	57.3
180% of p^{GR}	18.3	1.5	13.8	9.1	57.3
Reduced labor income risk	21.2	12.9	6.7	0.2	59.1
$\gamma^{GR} = \gamma^{I} = 0$	7.8	12.4	13.5	9.0	57.4

Table 11: Insurance statistics for model with GR contracts for different experiments (steady-state)

The welfare effects from introducing guaranteed renewable contracts do not change much once Medicaid is removed: the consumption equivalent variation goes up from 0.0696% to 0.0715%. People who rely on Medicaid are low-income people who cannot afford health insurance on their own. As observed from the second row of Table 11, most of the publicly insured people become uninsured once Medicaid is removed. So they are indifferent between having access to guaranteed renewable contracts or not. This happens because people are exposed to reclassification risk when they buy insurance contracts that deviate from the first best. For people who never buy private insurance contracts, these deviations from the first best do not matter.

The situation is very different when ESHI is removed. As can be seen in the third row of Table 10, the removal of ESHI increases the consumption equivalent variation almost tree times, from 0.0696% to 0.1774%. This implies that without ESHI individuals are more exposed to reclassification risk, thus guaranteed renewable contracts become more valuable.

Figures 10 and 11 illustrate this point further. The elimination of Medicaid has almost no effect on the demand for guaranteed renewable insurance for people in all income and asset quintiles. In contrast, if there is no ESHI, the take-up rates of guaranteed renewable insurance increase dramatically. The most noticeable changes are observed among high-income people in the top two asset quintiles. Previously this group had a very low demand for guaranteed renewable contracts. Once ESHI is removed, the majority of this group start buying new contracts. As a result, the negative relationship between the take-up rates of guaranteed renewable contracts and income observed in Figure 8 disappears.

Figure 11 shows how welfare effects from the new contracts differ by income and asset quintiles in the environment when either Mediciad or ESHI is not available. People who gain the most from having an explicit insurance against reclassification risk in the absence of ESHI are those in the high-income group. In the baseline economy most of these people have access to community rated insurance through their employers. For them ESHI is a good source of reclassification risk insurance. Once this institutional feature is removed, high-income people place much higher value on having access to guaranteed renewable contracts.

Minimum consumption floor

A major problem with reclassification risk is that it decreases the insurability of health shocks. If premiums increase following a deterioration of the health status, insurance may become unaffordable. Thus, people are more concerned about reclassification risk if it is very painful to be uninsured.

The consumption minimum floor provides support for people who depleted all resources. This includes uninsured people with high medical costs. Thus, the consumption

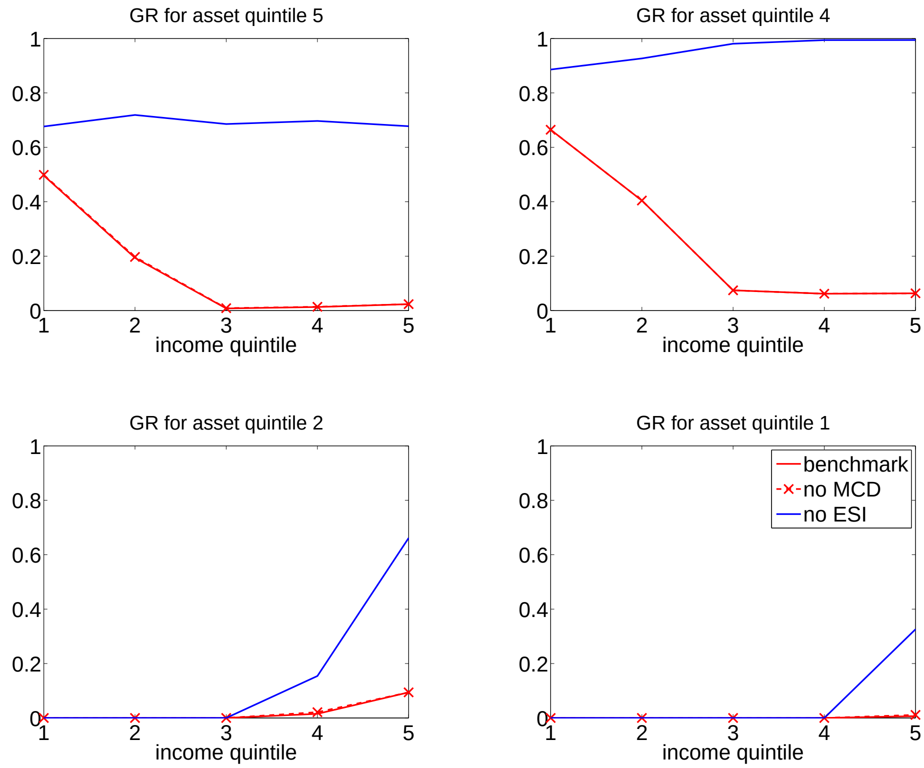

Figure 10: Fraction of people buying GR contracts by income and asset quintile (effect of ESHI/MCD)

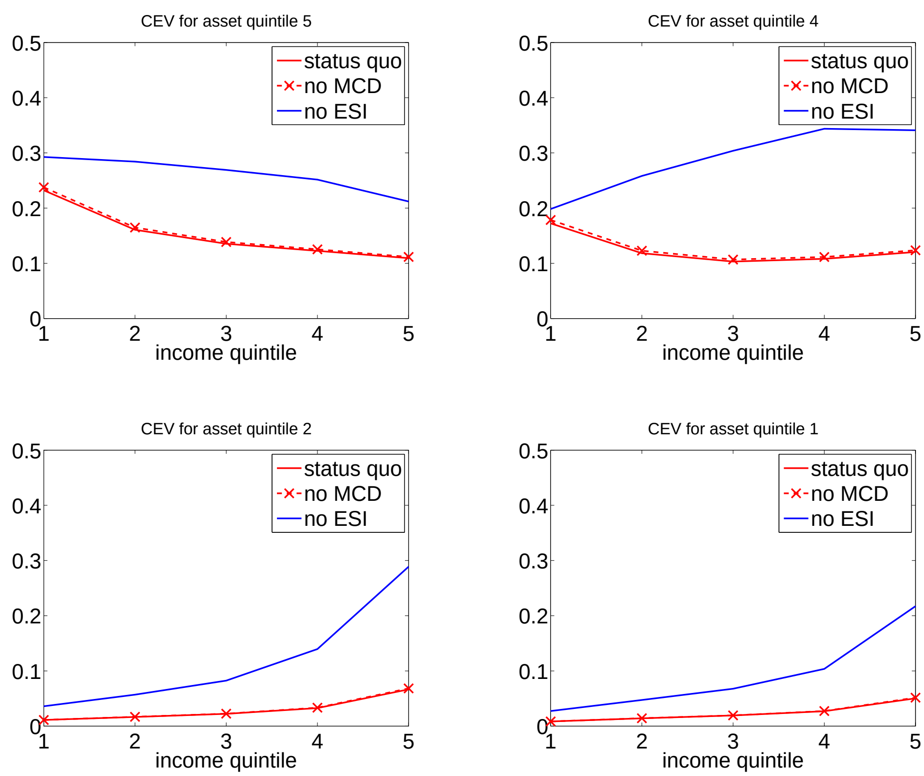

Figure 11: Consumption Equivalence by income and asset quintile (effect of ESHI/MCD)

floor mitigates the consequences of being uninsured and decreases the concern of lacking protection against reclassification risk.

To understand the quantitative significance of this effect, we reevaluate the welfare gains from guaranteed renewable contracts in an economy with a reduced consumption minimum floor. The seventh to tenth rows of Table 10 show the welfare effects when the consumption minimum floor is equal to 75%, 50%, 25% and 10% of its level in the baseline model. The resulting changes in welfare gains are substantial. When the consumption floor decreases to 10% of the baseline level, the average consumption equivalent variation increases more than 30 times - from 0.0696% to 2.3293%.

To illustrate the role of the minimum consumption floor in more details, Figures 12 and 13 show how the demand for guaranteed renewable contracts and welfare gains change in response to a decline in the consumption floor for people with different income and asset levels. In terms of the demand for new insurance contracts, most noticeable changes are observed among people in the bottom two asset quintiles. When the consumption floor is reduced to 25% of the baseline level, a lot of people in this group start buying guaranteed renewable contracts while previously their participation in this market was almost zero (Figure 8). We do not see a similar response from the high-asset group because these people buy guaranteed renewable contracts even when the consumption floor is high. Those high-asset individuals who do not buy guaranteed renewable contracts are insured by ESHI and a change in the consumption floor does not affect their insurance decisions.

In terms of welfare, the consumption equivalent variation increases substantially for all people except those in the very bottom of both income and asset distribution. The later group has no resources and always qualifies even for the least generous means-tested transfers. It is important to note that even people with high assets value guaranteed renewable contracts substantially more once the consumption minimum floor decreases. This happens because these people may also face unaffordable health insurance premiums after a sequence of bad health shocks. Since there is less chance they can rely on the consumption floor in this situation, they value an explicit insurance against unaffordability of premiums more[23].

Different degree of front-loading

The welfare gains from the availability of an explicit insurance against reclassification risk may also be affected by the design of this insurance. Guaranteed renewable contracts

[23] This result is consistent with the findings of De Nardi et al. (2010) who showed that social insurance has a large effect even on people at the top end of income distribution.

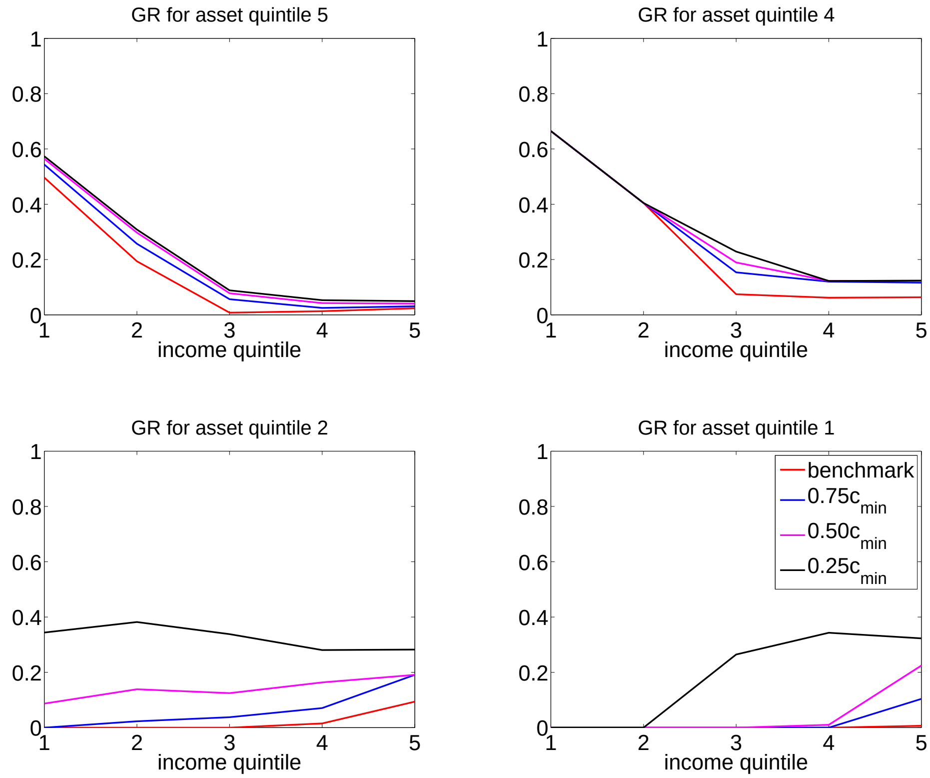

Figure 12: Fraction of people buying GR contracts by income and asset quintile (effect of $\underline{c}$)

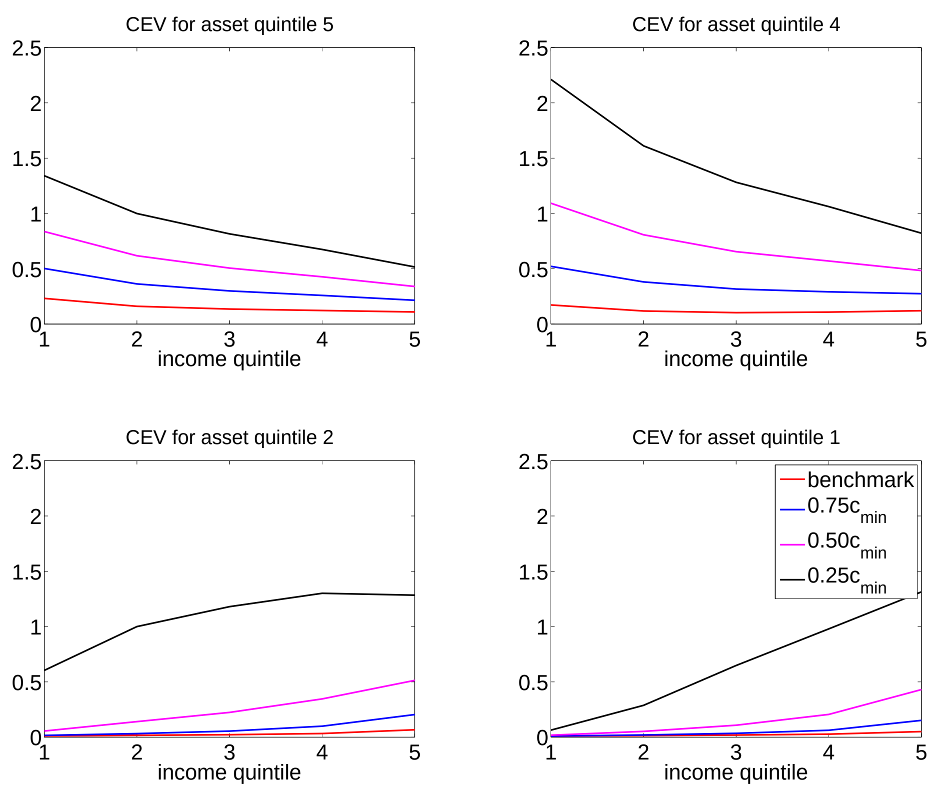

Figure 13: Consumption Equivalence by income and asset quintile (effect of $\underline{c}$)

are front-loaded and it may be the case that the amount of front-loading is in sharp contrast with what would be optimal from the point of view of intertemporal consumption smoothing. In general, if guaranteed renewable contracts are more front-loaded they provide more reclassification risk insurance because they lock more consumers into the contract, thus having better risk composition as time goes by. This comes at the cost of being more expensive and also being further away from the optimal intertemporal allocation of resources. In other words, there is a tradeoff between better insurance against reclassification risk and better intertemporal allocation. This tradeoff may become worse in the environment with uninsurable labor income risks. In such an environment consumers want to keep a buffer stock of savings against negative labor income shock and thus may be less interested in front-loaded contracts that require prepayments for risks that will be realized far into the future.

To understand whether the tradeoff between optimal consumption smoothing and reclassification risk insurance plays an important role in consumers' valuation of guaranteed renewable contracts, we consider two experiments. We reduce the degree of front-loading by increasing the price that renewable contracts guarantee, first, to 125% and then to 180% of the original price[24]. In other words, if previously an individual is guaranteed to be able to buy health insurance at the unchanged price, now he is guaranteed the price will not increase more than 25% or 80% of the original price.

Table 10 shows that lowering the degree of front-loading makes welfare gains smaller: the consumption equivalent variation decreases to 0.0645% and 0.0622% for the case of 125% and 180% contracts correspondingly. This suggests that design of guaranteed renewable contracts does not affect our evaluation of welfare costs of reclassification risk.

Labor income risk

Another factor that can affect how much people value guaranteed renewable contracts is labor income risk. Uninsurable and persistent labor income shocks can affect both people's attitude towards reclassification risk and their ability to participate in long-term insurance contracts.

Labor income risks can make it harder to participate in long-term insurance contracts. Guaranteed renewable contracts require periodic payments to stay in force. Individuals who experience a bad income shock may find their next payment unaffordable and thus have to terminate the contract. On the other hand, labor income risks make people more concerned about being uninsured because if a medical shock coincides with a negative labor income shock it will make their situation worse[25].

[24]Using example from Section 2, this is equivalent to setting $p_2^{GR} = 1.25 * p_1^{GR}$ and $p_2^{GR} = 1.8 * p_1^{GR}$. In all the previous experiments we have $p_2^{GR} = p_1^{GR}$.

[25]As discussed in De Santis (2007), the welfare function is convex in the overall consumption risk. Labor income shocks augment overall risk; thus removing the labor income risk makes the welfare cost

To understand whether labor income shocks significantly affect people's valuation of insurance against reclassification risk, we conduct an experiment where we reduce labor income risk. Specifically, in this experiment we change the labor income distribution in such a way that the cross-sectional variance of labor income is equal to 15% of the baseline case [26]. As shown in Table 10, the welfare gain from having a protection against reclassification risks is still small; more specifically the consumption equivalence drops from 0.0696% to 0.0244%. Table 11 shows that less people buy guaranteed renewable contracts when facing lower labor income risks: the fraction of people with new contracts goes down from 9.8% to 6.7%. This suggests that labor income risk does not prevent people from buying guaranteed renewable contracts, on the contrary it makes the additional insurance more valuable.

Actuarial unfairness of premiums

Finally, we consider whether actuarial unfairness plays an important role in the valuation of guaranteed renewable contracts. Even if reclassification risk is costly in terms of welfare, people may not value insurance against this risk if it is actuarially unfair. We consider the case when administrative loads are entirely eliminated from both standard and guaranteed-renewable contracts[27]. The results of this experiment are presented in the last column of Table 10. The welfare gains change very little, going up from 0.0696% to 0.0905%, suggesting that actuarial unfairness does not significantly affect people's valuation of guaranteed renewable contracts.

7 Implication for the health insurance reform

In March of 2010 President Obama signed the Patient Protection and Affordable Care Act that is going to introduce significant changes in the U.S. health insurance system. This reform has two key components. First, it introduces a wide range of income-based transfers, i.e. subsidies and expansion of public coverage. Second, it changes the rules under which the individual insurance market operates. In particular, the new law does not allow insurance companies to differentiate premiums by individual's health status. In other words, it introduces community rating in the individual insurance market. To prevent cream-skimming behavior of insurers, the reform also prohibits insurance com-

of any additional uncertainty smaller.

[26]Technically, we keep the joint transition matrix of health, labor income, and ESHI offer the same as in the baseline model but assign a new labor income for each income grid. Denote z_j and $\widehat{z}_j$ as the original and new value for each income grid j. We define $\widehat{z}_j = 0.15z_j + 0.75\overline{z}$, where $\overline{z}$ is the cross-sectional average labor income in the baseline model. Since the invariant distribution over each income grid is the same, it is easy to show that the cross-sectional average of $\widehat{z}$ is $\overline{z}$, while its cross-sectional variance is 15% of that in the baseline case.

[27]In other words, we set $gamma^I = gamma^G = 0$.

panies to deny coverage to anyone. Finally, the new law mandates individuals to buy health insurance unless their income is very low.

In general, community rating is a regulatory approach to eliminate reclassification risk[28]. If insurance companies cannot charge sick people high prices there is no risk of premium fluctuations. As discussed in the Introduction, when the problem of reclassification risk is solved by making healthy pay for the sick, some additional arrangements are required. Otherwise people who are healthy or have low income will be unwilling or unable to participate. The reform ensures participation from the healthy by mandates, and low income people will be subsidized.

The results of this paper suggest that the value of community rating as a means to insure reclassification risk is small because the welfare costs of this risk in the current system are not large. This is consistent with the results of Pashchenko and Porapakkarm (2011) who evaluate how different components of the reform contribute to its welfare outcome and find that the contribution of community rating is very small. In contrast, all income-based transfers introduced by the reform have much higher welfare effects.

Another implication of our findings is that even if reclassification risk is important for welfare, good protection against it can be obtained through private markets. Community rating accompanied by individual mandates is a large scale intervention in the insurance market. As such it has non-trivial distorting effects on both households' and insurance firms' decisions. In this light a private market approach to solving the problem of reclassification risk may be an alternative worth considering.

8 Conclusion

This paper studies how important reclassification risk is for the welfare of consumers. Reclassification risk is believed to be an important problem in the individual health insurance market. Premiums in this market are risk-rated while a typical contract lasts for only one year. Individuals whose health status deteriorates can see a drastic increase in their health insurance premiums, and this reduces their ability to obtain health insurance.

We constructed a general equilibrium model and calibrated it using the MEPS dataset to replicate the key features of the U.S. economy. To evaluate welfare costs of reclassification risk, we consider the effect of introducing into this economy guaranteed renewable health insurance contracts. Guaranteed renewable contracts are private insurance contracts that provide protection against reclassification risk without requiring consumer's commitment or income based transfers.

We find that the welfare gains from having access to the explicit insurance against re-

[28]Kifman (2002) provides a detailed comparison between guaranteed renewable contracts and community rating as a means to insure reclassification risk.

classification risk through guaranteed renewable contracts are small. This is because two institutional features of the current system - employer-based insurance and consumption minimum floor - provide a good implicit protection against reclassification risk. While employer-sponsored insurance mostly provides insurance to high-income people, low-income people are protected by the consumption minimum floor. If these two institutions are removed, welfare gains from having access to guaranteed renewable contracts are large and can exceed 2% of the annual consumption. Our results are robust to the alternative design of guaranteed renewable contracts and the degree of actuarial unfairness in the health insurance market.

9 Appendix

9.1 Computational algorithm

We solved for the steady state equilibrium of the baseline model as follows.

1. Guess an initial interest rate r, price in the group insurance market p, the amount the firm offering ESHI subtracts from the wage of their workers c_E, prices of guaranteed renewable contracts $p^{GR}(h), h = 1..H$, and the tax parameter a_2[29].

2. Guess value functions for young and old. Solve the problems for young and old. We optimize with respect to savings and insurance decisions and evaluate the value function for points outside the state space grid using a Piecewise Cubic Hermite Interpolating Polynomial (PCHIP). Update the value functions and continue iterating until both value functions converge. Use convergent value functions to find policy functions.

3. Given the policy functions, simulate the households distribution using a non-stochastic method as in Young (2010).

4. Use the distribution of households and policy functions to compute government budget deficit/surplus. Gradually update the tax function parameter a_2, the interest rate r, insurance prices $p^{GR}(h), h = 1..H$, p, and the substraction from wage c_E. Repeat steps 2-3 until all these variables converge.

[29]We cannot prove the uniqueness of the equilibrium in the health insurance market, however our results are robust to alternative initial guesses of insurance prices (p and $p^{GR}(h), h = 1..H$).

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