U.S. Tax Policy and Health Insurance Demand: Can a Regressive Policy Improve Welfare? *

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Abstract

The U.S. tax policy on health insurance is regressive because it favors only those offered group insurance through their employers who tend to have a relatively high income. Moreover, the subsidy takes the form of deductions from the progressive income tax system giving higher-paid individuals a larger subsidy. To understand the effects of the policy, we construct a dynamic general equilibrium model with an endogenous demand for health insurance. We use the Medical Expenditure Panel Survey to calibrate the process for income, health expenditures and health insurance offer status through employers and succeed in matching the pattern of insurance demand as observed in the data. We find that despite the issues about the current policy, a complete removal of the subsidy results in a partial collapse of the group insurance market and a significant reduction in the insurance coverage and deteriorates welfare. There is, however, room for raising the coverage and significantly improving welfare by extending a refundable credit to the individual insurance market.

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1 Introduction

Our paper studies the effects of the tax policy on the health insurance decision of households in a general equilibrium framework and provides an example of a regressive policy that improves welfare. The premium for employer-based health insurance in the U.S. is both income and payroll tax deductible while individual health insurance purchased outside the workplace does not offer this tax break.[1] This tax policy is regressive in two ways. First, data indicate that labor income is positively correlated with the availability of employer-based health insurance, thus, workers with higher income are more likely to enjoy the tax break. We call this horizontal inequality. Second, conditional on being covered by employer-based health insurance, the policy is still regressive because the progressive income tax code in the U.S. implies that individuals with higher income in a higher marginal tax bracket receive a larger tax break than those with lower income. We call this vertical inequality.

We show that despite its regressiveness this tax policy is welfare improving. Our main result relies on the key difference between employer-based and individual health insurance. The former, also called group insurance, is required by law not to discriminate among employees based on health status, while in the latter insurance companies have an incentive to price-discriminate and offer lower rates to individuals with better health status. Insurance outside the workplace therefore offers less pooling and thus less risk-sharing than the employer-based insurance. Pooling in the group insurance, however, relies on healthy agents voluntarily cross-subsidizing agents with higher expenditures. Taking away the tax subsidy thus encourages adverse selection. Specifically, healthy agents leave the group insurance, thereby causing a collapse of pooling in the group market and an overall welfare loss. We also study what alternative tax reforms can be undertaken to eliminate some of the regressiveness while maintaining the pooling in the group contract.

Our work is a contribution to the literature of dynamic equilibrium models with heterogenous agents. The classic work of Bewley (1986), Imrohoroglu (1992), Huggett (1993) and Aiyagari (1994) has created a large literature studying uninsurable labor productivity risk. Many recent papers investigated issues such as risk-sharing among agents, wealth and consumption inequality and welfare consequences of market incompleteness.[2] We add to this literature by setting up a model in the tradition of Aiyagari (1994) but with idiosyncratic health expenditure risk which is partially insurable according to the endogenous insurance decisions.

Health expenditure shocks have been helpful in adding realism to Aiyagari-type models. For example, in Livshits, MacGee and Tertilt (2006) and Chatterjee, Corbae, Nakajima and Rios-Rull (2005), health expenditure shocks are an important source of consumer bankruptcies. Hubbard, Skinner, and Zeldes (1995) add a health expenditure shock to Aiyagari's model and argue that the social safety net discourages savings by low income households. Only high income households accumulate precautionary savings to shield themselves from catastrophic health expenditures. Palumbo (1999) and De Nardi, French and Jones (2005) incorporate heterogeneity in medical expenses in order to understand the pattern of savings among the elderly. Scholz et. al. (2006) also include uncertain medical expenditures for retirees to study retirement savings.

What is common among papers in the existing macro-literature is that health insurance is absent from the model and consequently a household's out-of-pocket expenditure process

[1]The value of the subsidy is substantial, about $133 billion in the year 2005, according to the Office of Management and Budget. The origin of the tax deductibility lies in the price and wage controls the federal government imposed during the World War II. Companies used the employer-provided health benefits as a non-price mechanism to compete for workers that were in short supply, thereby circumventing the wage controls. Subsequent to lifting the price and wage controls, employers kept providing health plans partly because they could be financed with pre-tax income. The tax deductibility was extended to health insurance premiums of self-employed individuals in 1986.

[2]See for example Fernandez-Villaverde and Krueger (2004) and Krueger and Perri (2005).

is exogenous.[3] Our paper is also related to the literature on income taxation in incomplete markets with heterogeneous agents, particularly the macroeconomic implication and welfare and distributional effects of alternative tax systems.[4] A tax reform will generate a new path of factor prices, which affects heterogeneous agents in different ways.

In our paper we set up an overlapping generation general equilibrium model with endogenous health insurance demand to evaluate the merits of the tax-deductibility of group health insurance. Within our micro-founded framework, we conduct policy experiments based on optimized decision rules, which enables us to compare the welfare effect of policy experiments as well as the changes in the insurance demand. Moreover, we can take into account important general equilibrium effects. For example, our model can evaluate the fiscal consequences of policy reforms. Eliminating the subsidy may require a lower tax rate on other sources of income which can reduce distortions in other sectors, or alter the demand for social welfare programs such as Medicaid. It is difficult to compute welfare consequences of these policy experiments without an optimizing model of the household. Changing the tax treatment of health insurance premiums will also affect agents' savings behavior (and thus the aggregate capital stock and factor prices) directly through marginal taxes as well as indirectly because health insurance influences the precautionary savings motives. In each policy experiment, we first compute a steady state outcome and then explicitly compute the transition dynamics between the calibrated benchmark and the new steady state implied by an alternative policy in order to accurately assess the welfare consequences on the current generations.

Our quantitative analysis shows that completely removing the tax subsidy would substantially decrease the health insurance coverage and negatively affect welfare because of a partial collapse of the group insurance market. This is due to adverse selection, whereby the healthy agents drop out of the group insurance market as they are no longer willing to subsidize higher risk agents in that pool. This flight out of group insurance and into the individual contract with less pooling will be exacerbated by the increase in the group insurance premium, once the healthiest agents drop out. Indeed, there is a historical example of such a collapse of a pooling insurance contract in the face of competition from other contracts with price discrimination. In the 1950s Blue Cross and Blue Shield offered individual insurance that was community-rated, i.e., it was offered at a price independent of health conditions. However, other companies soon entered the market, screening applicants and offering lower rates to relatively healthy agents. Blue Cross and Blue Shield were left with the bad health risks and were forced to discontinue the community rating in the individual insurance market.[5] A similar mechanism of adverse selection is at work in our model.

There are other ways of reducing inequality without completely removing the tax subsidy. Eliminating vertical inequality by removing the regressiveness of tax benefits will reduce the benefit of group insurance for with high marginal tax rates and increase the benefit for those with low tax rates.

To restore horizontal equity, there are many paths the government could take. Various reform proposals are being debated in the policy arena, such as extending the deductibility to the non-group insurance market or providing a subsidy for any insurance purchase. We simulate such

[3]Papers that deal with health insurance policy outside of a heterogenous agent framework include Kotlikoff (1989) and Gruber (2004). Kotlikoff builds an OLG model where households face idiosyncratic health shocks and studies the effect of medical expenditures on precautionary savings. He considers different insurance schemes, such as self-payment, insurance, or Medicaid, which agents take as exogenously given. In our paper, we combine all three of them into one model and let households decide how they want to insure against health expenditure shocks. Gruber measures the effects of different subsidy policies for non-group insurance on the fraction of uninsured by employing a micro-simulation model that relies on reduced-form decision rules for households.

[4]See for example Domeij and Heathcote (2004), Castaneda, Diaz-Gimenez and Rios-Rull (2005), Conesa and Krueger (2006), Conesa, Kitao and Krueger (2006).

[5]Thomasson (2004) provides a nice historical background of the events.

reforms and find they are effective in raising the insurance coverage and improving welfare to varying degrees. We find that the best suited reform involves giving a lump-sum subsidy to those without employer-based insurance to purchase individual insurance. This policy reduces the regressiveness of the subsidy without triggering a flight out of the group insurance market, thereby maintaining the pooling in the group market.

The paper proceeds as follows. Section 2 introduces the model. Section 3 details the parameterizations of the model. Some parameters will be estimated within the model by matching moments from the data and others will be calibrated. Section 4 shows the numerical results of the computed model both from the benchmark and from policy experiments. Section 5 concludes.

2 Model

2.1 Demographics

We employ an overlapping generations model with stochastic aging and dying. The economy is populated by two generations of agents, the young and the old. The young agents supply labor and earn the wage income. Old agents are retired from market work and receive social security benefits.[6] The young agents become "old" and retire with probability ρ_o every period and old agents die with probability ρ_d. We will later calibrate the probabilities so as to match the current age structure of the two generations.

We assume the population remains constant. Old agents who die and leave the model are replaced by the entry of the same number of young agents. The initial assets of the entrants are assumed to be zero. This demographic transition pattern generates a fraction of $\frac{\rho_d}{\rho_d+\rho_o}$ of young people in each generation and a fraction of $\frac{\rho_o}{\rho_d+\rho_o}$ of old people. All bequests are accidental and they are collected by the government and transferred in a lump-sum manner.

2.2 Endowment

Agents are endowed with a fixed amount of time and the young agents supply labor inelastically. Their labor income depends on an idiosyncratic stochastic component z and the wage rate w, and it is given as wz. Productivity shock z is drawn from a set $\mathbb{Z} = \{z_1, z_2, ..., z_{N_z}\}$ and follows a Markov process that evolves jointly with the probability of being offered employer-based health insurance, which we discuss in the next subsection. Newly born young agents make a draw from the unconditional distribution of this process.

2.3 Health and health insurance

In each period, agents face an idiosyncratic health expenditure shock x.[7] Young agents have access to the health insurance market, where they can purchase a contract that covers a fraction $q(x)$ of the medical cost x. Therefore, with the health insurance contract, the net cost of restoring

[6] In the computation, we distinguish the old agents who just retired in the previous period from the rest of the old agents and call the former as "recently retired" agents and the latter as "old" agents. The distinction between the two old generations is necessary because recently retired agents have a different state space from the rest of the old agents as we discuss below.

[7] An alternative way would have been to model health expenditures endogenously. For example Grossman (1972) models health much like a durable good that can depreciate, but can also be replenished at a cost. We did not feel that endogenizing health expenditures that way adds much to our model. Our main result is that there is a rationale to subsidize group health insurance to keep those with low health expenditure in the group insurance pool. Explicitly modeling health gives the same result: The government should subsidize group insurance to keep those with low health depreciation in the group insurance pool.

the health will be $(1 - q(x))x$, while it will cost the entire x without insurance. Notice that we allow the insurance coverage rate q to depend on the size of the medical bill x. As we discuss in the calibration section, q increases in x due to deductibles and copayments. Agents must decide whether to be covered by insurance before they discover their expenditure shock.

Agents can purchase health insurance either in the individual market or through their employers. We call a contract purchased in the first market "individual health insurance (IHI)" as opposed to "group health insurance (GHI)" purchased in the workplace. While every agent has access to the individual market, group health insurance is available only if such a benefit plan is offered by the employer. Notice that we assume that the coverage ratios q are the same across. This is because we found no significant difference between the GHI and IHI coverage ratios.

In our model we assume that there is an exogenous probability of getting a GHI offer. Specifically, the probability of being offered health insurance at work and the labor productivity shock z evolve jointly with a finite-state Markov process. As we discuss more in the calibration section, we do this because firms' offer rates differ significantly across income groups. Moreover, for workers, the availability of such benefits is highly persistent and the degree of persistence varies according to the income shocks. The transition matrix $\Pi_{Z,E}$ has the dimension $(N_z \times 2) \times (N_z \times 2)$, with an element $p_{Z,E}(z, i_E; z', i'_E) = prob(z_{t+1} = z', i_{E,t+1} = i'_E | z_t = z, i_{E,t} = i_E)$. i_E is an indicator function, which takes a value 1 if the agent is offered group health insurance and 0 otherwise. Notice that the transition probability is conditional on not aging.

Instead of using this exogenous process for the GHI offers, we could have modelled the demand and supply decisions of workers and firms jointly in a search, matching and bargaining environment. For example Dey and Flinn (2005) use such a model to study how employer-based health insurance affects job mobility. However, their model is not suitable for the policy analysis we have in mind. They assume an exogenous health insurance premium and abstract from a market for individual health insurance. Our model endogenizes the health insurance demand in different markets as well as the insurance premium and studies how a change in policy affects the premium and workers' trade-off between employer-based and individual health insurance in a general equilibrium. The change in the price for group health insurance and incentives of agents to drop out of the GHI and switch to IHI are shown to be important channels that will drive our results. For our purposes, therefore, we keep the health insurance supply side somewhat simpler to study the demand side in a Bewley (1986) and Aiyagari (1994) type environment and thus in much more detail than otherwise possible.

Of course, the drawback of modelling the supply side of GHI in such an exogenous way is that we could miss important general equilibrium effects once we perform policy experiments. For example a change in the treatment of the GHI premium may change the share of firms offering health insurance. Therefore, when we run policy experiments we will draw on estimates in the empirical literature of how changes in the after-tax price of the GHI contract affect offer rates of employer health insurance. We will alter the transition matrix to account for the supply side effects estimated in the literature. See Section 4.2 for details.

If a young agent decides to purchase group health insurance through his employer, a constant premium p must be paid to an insurance company in the year of the coverage. The premium is not dependent on prior health history or any individual states. This accounts for the practice that group health insurance will not price-discriminate the insured by such individual characteristics.[8]

[8]Clearly, firms have an incentive to price-discriminate, i.e., charge a higher insurance premium to individuals with an adverse health condition, but labor regulations prevent such discrimination. U.S. Department of Labor Release 01-14 states: "[N]ondiscrimination provisions generally prohibit a group health plan or group health insurance issuer from [...] charging an individual a higher premium than a similarly situated individual based on a health factor. Health factors include: health status, medical condition (including both physical and mental illnesses), claims experience, receipt of health care, medical history, genetic information, evidence of insurability (including conditions arising out of acts of domestic violence), and disability."

We also allow the employer to subsidize the premium. More precisely, if an agent works for a firm that offers employer-based health insurance benefits, a fraction $\psi \in [0,1]$ of the premium is paid by the employer, so the marginal cost of the contract faced by the agent is only $(1-\psi)\,p$.[9] In the individual health insurance market, we assume that the premium is $p_m(x)$, that is, the premium depends on the current health expenditure state x.[10] This reflects the practice that in contrast to the group insurance market, there is price discrimination in the individual health insurance market. Specifically, IHI contracts normally are contingent on age and prior conditions or even rule out payment for preexisting conditions.

We assume that all old agents are enrolled in the Medicare program. Each old agent pays a fixed premium p_{med} every period for Medicare and the program will cover the fraction $q_{med}(x)$ of the total medical expenditures. Young agents pay the Medicare tax τ_{med} that is proportional to the labor income. We assume that old agents do not purchase individual health insurance and their health costs are covered by Medicare and their own resources, plus social insurance if applicable.[11]

Health expenditures x follow a finite-state Markov process. For the two generations $j = y$ (young) or o (old), expenditure shocks are drawn from the generation-specific set $\mathbb{X}^j = \{x_1^j, x_2^j, ..., x_{N_x}^j\}$, with a transition matrix Π_x^j, where probability is defined as $p_x(x, x') = prob(x_{t+1} = x' | x_t = x)$. We assume that if a young agent becomes old, he makes a draw from the set $\mathbb{X}^o$ according to the transition matrix of the old agents, conditional upon the state in the previous period.

2.4 Preferences

Preferences are assumed to be time-separable with a constant subjective discount factor β. One-period utility from consumption is defined as a CES form, $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$, where σ is the coefficient of relative risk aversion.

2.5 Firms and production technology

A continuum of competitive firms operate a technology with constant returns to scale. Aggregate output is given by

$$F(K, L) = AK^{\alpha}L^{1-\alpha}, \tag{1}$$

where K and L are the aggregate capital and labor efficiency units employed by the firm's sector and A is the total factor productivity, which we assume is constant. Capital depreciates at rate δ every period.

[9]Notice that the subsidy, too, could be modelled as the outcome of a worker-firm bargaining process. However, we assume that the employer subsidy is given exogenously, calibrated in the benchmark to values observed in the data. In the policy experiments we rely on empirical estimates on how employers alter the generosity of the subsidy when the premium changes in equilibrium. See Section 4.2 for details.

[10]There are other important features and issues in the individual insurance market. In particular, limited information of insurers on the health status of individuals could cause adverse selection, raise the insurance premium and shrink the market as analyzed in Rothschild and Stiglitz (1976). Other issues include coverage exclusion of pre-existing health conditions, overuse of medical services due to generous deductible and copayments (moral hazard), etc. We do not model them in the benchmark economy in order to keep the model tractable.

[11]Many old agents purchase various forms of supplementary insurance, but the fraction of health expenditures covered by such insurance is relatively small and it is only 15% of total health expenditures of individuals above age 65 (MEPS, 2001), and we choose to assume away the individual insurance market for the old, because the old generation is not the primary focus of our model. 97% of people above age 65 are enrolled in Medicare and the program covers 56% of their total health expenditures. For more on the health insurance of the old, see for example Cutler and Wise (2003).

As discussed above, if a firm offers employer-based health insurance benefits to its employees, a fraction $\psi \in [0,1]$ of the insurance premium is paid at the firm level. The firm needs to adjust the wage to ensure the zero profit condition. The cost c_E is subtracted from the marginal product of labor, which is just enough to cover the total premium cost that the firm has to pay.[12] The adjusted wage is given as

$$w_E = w - c_E, \tag{2}$$

where $w = F_L(K, L)$ and c_E, the employer's cost of health insurance per efficiency unit, is defined as

$$c_E = \mu_E^{ins} p \psi \frac{1}{\sum_{k=1}^{N_z} z_k \bar{p}_{Z,E}(k|i_E = 1)}, \tag{3}$$

where μ_E^{ins} is the fraction of workers that purchase health insurance, conditional on being offered such benefits, i.e. $i_E = 1$. $\bar{p}_{Z,E}(k|i_E = 1)$ is the stationary probability of drawing productivity z_k conditional on $i_E = 1$.[13]

2.6 The government

We impose government budget balance period by period. The social security and Medicare systems are self-financed by proportional taxes τ_{ss} and τ_{med} on labor income.

There is a "safety net" provided by the government, which we call social insurance. The government guarantees a minimum level of consumption $\bar{c}$ for every agent by supplementing the income in case the agent's disposable assets fall below $\bar{c}$, as in Hubbard, Skinner and Zeldes (1995). The social insurance program stands in for all other social assistance programs such as Medicaid and food stamp programs.

The government levies tax on income and consumption to finance expenditures G and the social insurance program. Labor and capital income are taxed according to a progressive tax function following Gouveia and Strauss (1994) and consumption is taxed at a proportional rate τ_c. We provide more details on the tax system below.

2.7 Households

The state for a young agent is summarized by a vector $s_y = (a, z, x, i_{HI}, i_E)$, where a is assets brought into the period, z is the idiosyncratic shock to productivity, x is the idiosyncratic health expenditure shock from the last period that has to be paid in the current period and i_{HI} is an indicator function that takes a value 1 if the agent held health insurance in the last period and 0 otherwise. The indicator function i_E signals the availability of employer-based health insurance benefits in the current period.

The timing of events is as follows. A young agent observes the state (a, z, x, i_{HI}, i_E) at the beginning of the period, then pays last period's health care bill x, makes the consumption and savings decision, pays taxes and receives transfers and also decides on whether to be covered by health insurance. After the agent has made all decisions, this period's health expenditure

[12] The assumption behind this wage setting rule is that a firm does not adjust salary according to individual states of a worker. A firm simply employs efficiency units optimally that consist of a mix of workers of different states according to their distribution. The employer-based insurance system with a competitive firm in essence implies a transfer of a subsidy from uninsured to insured workers. Our particular wage setting rule assumes the subsidy for each worker per efficiency unit is the same across agents in the firm.

An alternative is to assume that a firm adjusts the wage conditional on the purchase decision of group insurance by each agent (i.e. the wage adjustment depends on all the state variables of an agent) or on some sates. We made our choice in light of realism.

[13] It is easy to verify that this wage setting rule satisfies the zero profit condition of a firm that employs labor N: wN = (total salary) + (total insurance costs paid by the firm).

shock x' and next period's generation, i.e. whether he retires or not, and productivity and offer status are revealed. Together with allocational decisions a' and i'_{HI} they form next period's state $s'_y = (a', z', x', i'_{HI}, i'_E)$. The agent makes the health insurance decision i'_{HI} after he or she finds out whether the employer offers group insurance but before the health expenditure shock for the current period x' is known. Also notice that agents pay an insurance premium one period before the expenditure payment occurs. Therefore the insurance company also earns interest on the premium revenues accrued during one period.

Since the arrangements for the health expenditure payment differ between young workers and retirees and agents pay their health care bills with a one period lag, we have to distinguish between recently retired agents and the rest of the old agents. The former, which we call a 'recently retired agent', has to pay the health care bill of his last year, potentially covered by an insurance contract he purchased as a young agent, while an existing old person, which we call simply an 'old agent', is covered by Medicare. As a result, the state for recently aged agents is given as $s_r = (a, x, i_{HI})$ and for the other old agents $s_o = (a, x)$.

We write the maximization problems of all three generations of agents (young, recently retired and old) in a recursive form. In the value functions the subscript denotes the generation of an agent, where y stands for young agents, r stands for recently retired and o refers to old agents:

Young agents' problem

$$V_y(s_y) = \max_{c,a',i'_{HI}} \left\{ u(c) + \beta \left\{ (1-\rho_o)\, E\left[V_y\left(s'_y\right)\right] + \rho_o E\left[V_r\left(s'_r\right)\right]\right\}\right\} \tag{4}$$

subject to

$$\begin{aligned} (1+\tau_c)c + a' + (1 - i_{HI}\cdot q\,(x))\, x &= \tilde{w}z - \tilde{p} + (1+r)(a+T_B) - Tax + T_{SI} \\ i'_{HI} &\in \{0,1\} \\ a' &\geq \underline{a} \end{aligned} \tag{5}$$

where

$$\tilde{w} = \begin{cases} (1-0.5(\tau_{med}+\tau_{ss}))\, w & \text{if } i_E = 0 \\ (1-0.5(\tau_{med}+\tau_{ss}))\,(w - c_E) & \text{if } i_E = 1 \end{cases} \tag{6}$$

$$\tilde{p} = \begin{cases} p\cdot(1-\psi) & \text{if } i'_{HI} = 1 \text{ and } i_E = 1 \\ p_m(x) & \text{if } i'_{HI} = 1 \text{ and } i_E = 0 \\ 0 & \text{if } i'_{HI} = 0 \end{cases} \tag{7}$$

$$Tax = T(y) + 0.5(\tau_{med}+\tau_{ss})(\tilde{w}z - i_E\cdot\tilde{p}) \tag{8}$$

$$y = \max\{\tilde{w}z + r(a+T_B) - i_E\cdot\tilde{p}, 0\} \tag{9}$$

$$T_{SI} = \max\left\{0, (1+\tau_c)\bar{c} + (1-i_{HI}\cdot q\,(x))\, x + T(\tilde{y}) - \tilde{w}z - (1+r)(a+T_B)\right\} \tag{10}$$

$$\tilde{y} = \tilde{w}z + r(a+T_B)$$

The young agents' choice variables are (c, a', i'_{HI}), where c is consumption, a' is the riskless savings and i'_{HI} is the indicator variable for this period's health insurance which covers expenditures that show up in next period's budget constraint. Remember that the current state x is last period's expenditure shock while the current period's expenditure x' is not known when the agents makes the insurance coverage decision. Agents retire with probability ρ_o, in which case the agent's value function will be that of a recently retired old, $V_r(s'_o) = V_r(a', x', i'_{HI})$, as defined below.

Equation (5) is the flow budget constraint of a young agent. Consumption, saving, medical expenditures and payment for the insurance contract must be financed by labor income, saving from previous period and a lump sum bequest transfer plus accrued interest $(1+r)(a+T_B)$, net of income and payroll taxes Tax plus social insurance transfer T_{SI} if applicable. a' cannot exceed the borrowing limit $\underline{a}$. $\tilde{w}$ is the wage per efficiency unit already adjusted by the employer's portion of payroll taxes and benefits cost as specified in equation (6). If the agent's employer does not offer health insurance benefits, it equals $(1-0.5(\tau_{med}+\tau_{ss}))\,w$, that is, the marginal product of labor net of employer payroll taxes. If the employer does offer insurance, the wage is reduced by both c_E, which is the health insurance cost paid by a firm as defined in equations (2) and (3), and the payroll tax. Consequently, one could interpret the $\tilde{w}z$ as the gross salary.

Payroll taxes are imposed on the wage income net of paid insurance premium if it is provided through an employer, as shown in the RHS of equation (8).[14] Equation (9) represents the income tax base; labor income paid to a worker plus accrued interest on savings and bequests less the insurance premium, again provided that the purchase is through the employer. The taxes are bounded below by zero.

The term T_{SI} in equation (10) is a government transfer that guarantees a minimum level $\bar{c}$ of consumption for each agent after receiving income, paying taxes and health care costs. The health insurance premium for a new contract is not covered under the government's transfer program.

The marginal cost of the insurance premium $\tilde{p}$ depends on the state i_E as given in equation (7).[15]

Recently retired agents' problem

$$V_r\left(s_r\right)=\max_{c,a'}\left\{u(c)+\beta\left(1-\rho_d\right)E\left[V_o\left(s_o'\right)\right]\right\} \tag{11}$$

subject to

$$\begin{aligned}
(1+\tau_c)c+a'+\left(1-i_{HI}\cdot q\left(x\right)\right)x &= ss-p_{med}+(1+r)(a+T_B)-T(y)+T_{SI} && (12)\\
y &= r(a+T_B) && (13)\\
T_{SI} &= \max\left\{0,(1+\tau_c)\bar{c}+\left(1-i_{HI}\cdot q\left(x\right)\right)x\right.\\
&\quad \left.+p_{med}-ss-(1+r)(a+T_B)+T(y)\right\} && (14)\\
a' &\geq \underline{a}
\end{aligned}$$

Old agents' problem

$$V_o\left(s_o\right)=\max_{c,a'}\left\{u(c)+\beta\left(1-\rho_d\right)E\left[V_o\left(s_o'\right)\right]\right\} \tag{15}$$

[14]To be precise, the payroll tax base at each of firm and individual levels is bounded below by zero, and we have

$$Tax=T(y)+0.5(\tau_{med}+\tau_{ss})\cdot\max\{\tilde{w}z-i_E\cdot\tilde{p},0\}.$$

For simplicity we present it as in equation (8), which is applicable when the zero boundary condition does not bind. The zero lower bound condition also applies for the employer portion of payroll taxes.

[15]Agents who are offered insurance by employers also have access to the individual insurance market and can purchase a contract at the market price, which depends on the individual health status. Given the same coverage ratios offered by each contract, agents choose to be insured at the lowest cost taking into account the tax break which can be applied only when they choose to purchase an employer-based contract. In our benchmark model, however, no one chooses to buy an individual contract in such a case since the fraction ψ paid by employers makes an employer-based contract more attractive. This holds even for agents with the best health condition, who could buy a contract in the market at the lowest price. Hence we write the premium as $\tilde{p}=p(1-\psi)$, when $i_E=1$ and $i'_{HI}=1$.

subject to

$$
\begin{aligned}
(1+\tau_c)c + a' + (1 - q_{med}(x))\, x &= ss - p_{med} + (1+r)(a+T_B) - T(y) + T_{SI} && (16)\\
y &= r(a+T_B) && (17)\\
T_{SI} &= \max\{0, (1+\tau_c)\bar{c} + (1 - q_{med}(x))\, x \\
&\quad + p_{med} - ss - (1+r)(a+T_B) + T(y)\} && (18)\\
a' &\geq \underline{a}
\end{aligned}
$$

The choice variables of the two old generations are c, a'. The social security benefit payment is denoted by ss and p_{med} is the Medicare premium that each old agent pays. The only difference between the budget constraints of the two old generations is how health expenditures x are financed. The old agents are covered by Medicare for a fraction $q_{med}(x)$ of x and the recently retired agents are covered for $q(x)$ if they purchased an insurance contract in the previous period.

2.8 Health insurance company

The health insurance company is competitive. It charges premia p and $p_m(x)$ that precisely cover all expenditures on the insured. Moreover, we assume that there is no cross-subsidy across contracts, i.e. group and individual insurance contracts (for each health status) are self-financed and satisfy:

$$
\begin{aligned}
(1+r)\, p &= \frac{(1+\phi_G)\int \sum_{x'} p_y(x'|x)\, x' q(x')\, i_E i'_{HI}(s)\, \mu(s|j=y) ds}{\int i_E i'_{HI}(s)\, \mu(s|j=y) ds} && (19)\\
(1+r)\, p_m(x) &= \frac{(1+\phi_I)\int \sum_{x'} p_y(x'|x)\, x' q(x')\, (1-i_E)\, i'_{HI}(s)\, \mu(s|x, j=y) ds}{\int (1-i_E)\, i'_{HI}(s)\, \mu(s|x, j=y) ds} \quad \forall x && (20)
\end{aligned}
$$

where ϕ_G and ϕ_I denote a proportional markup for the group insurance contract and individual insurance contract respectively. We assume that this cost is a waste ('thrown away into the ocean') and does not contribute to anything. See the calibration section on how we choose those parameters. The assumption that the insurance company differentiate the prices for the health status in the individual market can be interpreted as the agents who apply for the insurance revealing their age, current health condition and past medical history and the insurance company utilizing the information and charging a premium that ensures zero expected profits based on the information.

2.9 Stationary competitive equilibrium

At the beginning of the period, each young agent is characterized by a state vector $s_y = (a, z, x, i_{HI}, i_E)$, i.e. asset holdings a, labor productivity z, health care expenditure x, and indicator functions for insurance holding i_{HI}, and employer-based insurance benefits i_E. Old agent has the state vector $s_r = (a, x, i_{HI})$ or $s_o = (a, x)$, depending on whether the agent is recently retired or not. Let $a \in \mathbb{A} = \mathbb{R}_+$, $z \in \mathbb{Z}$, $x \in \mathbb{X}$, $i_{HI}, i_E \in \mathbb{I} = \{0, 1\}$ and $j \in \mathbb{J} = \{y, r, o\}$ (y for the young, r the recently retired old and o for the rest of the old agents) and denote by $\mathbb{S} = \{\mathbb{J}\} \times \{\mathbb{S}_y, \mathbb{S}_r, \mathbb{S}_o\}$ the entire state space of the agents, where $\mathbb{S}_y = \mathbb{A} \times \mathbb{Z} \times \mathbb{X}_y \times \mathbb{I}^2$, $\mathbb{S}_r = \mathbb{A} \times \mathbb{X}_o \times \mathbb{I}$ and $\mathbb{S}_o = \mathbb{A} \times \mathbb{X}_o$. Let $s \in \mathbb{S}$ denote a general state vector of an agent: $s \in \mathbb{S}_y$ if young, $s \in \mathbb{S}_r$ if recently retired and $s \in \mathbb{S}_o$ if old.

The equilibrium is given by interest rates r, wage rate w and adjusted wage w_E; allocation functions $\{c, a', i'_{HI}\}$ for young and $\{c, a'\}$ for old; government tax system given by income tax function $T(I)$, consumption tax τ_c, Medicare, social security and social insurance program; accidental bequests transfer T_B; the individual health insurance contracts given as pairs of premium

and coverage ratios $\{p, q\}$, $\{p_m(x), q\}$; a set of value functions $\{V_y(s_y)\}_{s_y \in \mathbb{S}_y}$, $\{V_r(s_r)\}_{s_r \in \mathbb{S}_r}$ and $\{V_o(s_o)\}_{s_o \in \mathbb{S}_o}$; and distribution of households over the state space $\mathbb{S}$ given by $\mu(s)$,
such that

1. Given the interest rates, the wage, the government tax system, Medicare, social security and social insurance program, and the individual health insurance contract, the allocations solve the maximization problem of each agent.

2. The riskless rate r and wage rate w satisfy marginal productivity conditions, i.e. $r = F_K(K, L) - \delta$ and $w = F_L(K, L)$, where K and L are total capital and labor employed in the firm's sector.

3. A firm that offers employer-health insurance benefits pays the wage net of cost, given as $w_E = w - c_E$, where c_E is the cost of health insurance premium per efficiency unit paid by a firm, as defined in equation (3).

4. The accidental bequests transfer matches the remaining assets (net of health care expenditures) of the deceased.

$$T_B = \rho_d \int \left[a'(s) - \sum_{x'} p_o(x'|x) \{(1 - q_{med}(x'))\, x'\} \right] \mu(s|j = r, o) ds$$

5. The health insurance company is competitive, and satisfies conditions (19) and (20).

6. The government's primary budget is balanced.

$$G + \int T_{SI}(s)\, \mu(s) ds = \int [\tau_c c(s) + T(y(s))]\, \mu(s) ds$$

   where $y(s)$ is the taxable income for an agent with a state vector s.

7. Social security system is self-financing.

$$ss \int \mu(s|j = r, o) ds = \tau_{ss} \int (\tilde{w} z - 0.5 i'_{HI} \cdot i_E \cdot p\,(1 - \psi))\, \mu(s|j = y) ds$$

8. Medicare program is self-financing.

$$\begin{aligned} \int q_{med}(x)\, x \mu(s|j &= o) ds = \tau_{med} \int (\tilde{w} z - 0.5 i'_{HI} \cdot i_E \cdot p\,(1 - \psi))\, \mu(s|j = y) ds \\ + p_{med} \int \mu(s|j &= r, o) ds \end{aligned}$$

9. Capital and labor markets clear.

$$\begin{aligned} K &= \int [a(s) + T_B]\, \mu(s) ds + \int i'_{HI}\, (i_E p + (1 - i_E)\, p_m(x))\, \mu(s|j = y) ds \\ L &= \int z \mu(s|j = y) ds \end{aligned}$$

10. The aggregate resource constraint of the economy is satisfied.

$$G + C + X = F(K, L) - \delta K,$$

where

$$\begin{aligned} C &= \int c(s)\mu(s)ds \\ X &= \int x(s)\mu(s)ds. \end{aligned}$$

11. The law of motion for the distribution of agents over the state space $\mathbb{S}$ satisfies

$$\mu_{t+1} = R_\mu(\mu_t),$$

where R_μ is a one-period transition operator on the distribution.

3 Calibration

In this section, we outline the calibration of the model. A model period corresponds to one year. Table 2 summarizes the values and describes the parameters.

3.1 Endowment, health insurance and health expenditures

Data source: For a detailed description of the calibration process, please refer to Appendix A. For endowment, health expenditure shocks and health insurance, we use income and health data from one source, the Medical Expenditure Panel Survey (MEPS), which is based on a series of national surveys conducted by the U.S. Agency for Health Care Research and Quality (AHRQ). The MEPS consists of eight two-year panels 1996/1997 up to 2003/2004 and includes data on demographics, income and most importantly health expenditures and insurance. We drop the first three panels because one crucial variable that we need in determining the joint endowment and insurance offer process is missing in those panels.

To calibrate an income process, we consider wage income of all heads of households (both male and female), unlike many existing studies in the literature on stochastic income process (for example, Storesletten, et al (2004), who use households to study earnings process, and Heathcote, et al (2004), who use white male heads of households to estimate wage process). The main reason for not relying on those studies is that we want to capture the individual characteristics associated with health insurance and health expenditures across the dimension of the income shocks. It is possible only by using a comprehensive database like MEPS.

As a sample unit we choose heads of households. We choose heads instead of all individuals since many non-head individuals are covered by their spouses' health insurance. Our model also captures those with zero or very low level of assets, who would be eligible for public welfare assistance. Many households that fall in this category are headed by females, which is why we include both males and females. In addition, most of the existing studies on the income process are focused on samples with strictly positive income, often above some threshold level and such treatment does not fit in our model, either.

Endowment: We calibrate the endowment process jointly with the stochastic probability of being offered employer-based health insurance. For the income process, we avoid the detour of first estimating an AR(1) process and then discretizing with the methods of Tauchen (1986).

Instead, we specify the income distribution over the five income states so that in each year, an equal number of agents belong to each of the five bins of equal size. Then we determine for each individual in which bin he or she resides in the two consecutive years and thus construct the joint transition probabilities $p_{Z,E}(z, i_E; z', i'_E)$ of going from income bin z with insurance status i_E to income bin z' with i'_E. Recall i_E is an indicator function that takes a value 1 if employer-based health insurance is offered and 0 otherwise. The joint Markov process is defined over $N_z \times 2$ states with a transition matrix $\Pi_{Z,E}$ of size $(N_z \times 2) \times (N_z \times 2)$. We average the transition probabilities over the five panels weighted by the number of people in each panel. We display the transition matrix in Appendix A.

Finally, in order to get the grids for z, we compute the average income in each of the five bins in 2003 dollars. First we compute average income in 2003 dollars as \$34,093. The z relative to average income are

$$\mathbb{Z} = \{0.095, 0.484, 0.815, 1.238, 2.374\}$$

Notice that the income shocks look quite different from the ones normally used in the literature in that we include all heads of households, even those with zero income. This generates an extremely low income shock of about \$3,000 for a sizeable measure of the population. We assume that the agents cannot borrow, i.e. $\underline{a} = 0$. Given that the lowest possible income is quite small, the constraint is almost equivalent to imposing a natural borrowing limit.

The stationary distribution over the $(N_z \times 2)$ grids is given as

z grid number	1	2	3	4	5	sum
GHI offered (%)	3.1	11.3	14.9	16.4	16.9	62.6
GHI not offered (%)	17.1	8.6	5.0	3.6	3.1	37.4

There is an asymmetry in the income distribution for the agents with a group insurance offer and those without such an offer. A high income is more likely to be accompanied with the group insurance offer.

Health expenditure shocks: In the same way as for the endowment process, we estimate the process of health expenditure shocks and the transition probabilities directly from the MEPS data. We use seven states for the expenditures and for each of the young and the old generations, we specify the bins of size $(20\%, 20\%, 20\%, 20\%, 15\%, 4\%, 1\%)$. Young agents' expenditure grids are given as

$$\mathbb{X}_y = \{0.000, 0.005, 0.018, 0.047, 0.135, 0.397, 1.436\}$$

which are the mean expenditures in the seven bins in the first year of the last panel, that is, in the year 2002. The transition matrices for each young generation are displayed in Appendix A. The expenditures are normalized in terms of their ratios to the average labor income in 2003. This parametrization generates average expenditures of 6.6% of mean labor income in the young generation or \$2,195 in year 2003 dollars.

Notice that an advantage of our procedure is that we can specify the bins ourselves. Average expenditures in the first and second bins are less than 1% of average labor income. In contrast, expenditures are substantial in the top bins. For example, the top 1% of the third generation have average expenditures of about 1.5 times the average income (over \$48,000 in 2003). The next 4 percent have average expenditures of 40 percent of average income (over \$13,000) while the following 15 percent spend about 14 percent of average income (about \$4,600).

Likewise, using the same strategy for the old generation (common for $j = r$ and o) we obtain the expenditure grids

$$\mathbb{X}_o = \{0.005, 0.033, 0.077, 0.156, 0.397, 0.988, 2.209\}$$

and the transition matrix displayed in Appendix A, which generates unconditional expectation of x_o of 18.1% of mean income or \$5,936 in year 2003 dollars.

3.2 Health insurance

The coverage ratios of health insurance contracts are calibrated using the same five MEPS panels. Given that the coverage depends on and increases in the health expenditures incurred by the insured, we estimate a polynomial $q(x)$, the coverage ratio as a function of expenditures x. More details on the estimation of this function are given in Appendix A.4.

As mentioned before, there is a proportional operational cost incurred by insurance companies, which is passed through to the insurance premiums as a mark-up. The parameter ϕ_I for the individual contract is calibrated so that the model achieves the overall take-up ratio of 38 percent as in the MEPS data when the group insurance is not offered. Our estimate for ϕ_I is 11 percent based on the study in Kahn, et. al. (2005).[16] We assume that the same cost is added to the group insurance contract, i.e. $\phi_G = \phi_I$. Notice that this parameter does not correspond to the total administrative cost in the health care sector, which is sometimes estimated to be as high as one third. For example, Woolhandler et. al. (2003) estimate that in 1999, 31 percent of health expenditures were spent on administration, but most of these expenditures are on the provider side which are part of our calibrated cost of health care from MEPS already.

The group premium p is determined in equilibrium to ensure zero profits for the insurance company in the group insurance market. The average annual premium of an employer-based health insurance was \$2,051 in 1997 or about 7% of annual average labor income (Sommers (2002)). Model simulations yields a premium of 6.2% of average annual labor income.

A firm offering employer-based health insurance pays a fraction ψ of the premium. According to the MEPS, the average percent of total premium paid by employee varies between 11% and 23% depending on the industry in 1997 (Sommers, 2002). Other studies estimate figures in a similar range and we set the $1 - \psi$ to 20%.[17]

With regards to individual health insurance, the insurance company sets $p_m(x)$ to satisfy the equation (20), that is,

$$p_m(x) = (1 + \phi_I) E\{q(x')\, x' | x\} / (1 + r).$$

The expectation is with respect to the next period's expenditures x', and we compute the premium using the transition matrix Π_{x_y} as a function of last period's expenditures. In the benchmark model, the premiums in the unit of average labor income are given as follows.

bin	1	2	3	4	5	6	7
$p_m(x)$	0.0156	0.0245	0.0488	0.0860	0.1221	0.2358	0.4905

3.3 Demographics, preferences and technology

We define the generations as follows. Young agents are between the ages of 20 and 64, while old agents are 65 and over. Young agents' probability of aging ρ_o is set at 1/45 so that they stay for an average of 45 years in the labor force before retirement. The death probability ρ_d is calibrated so that the old agents above age 65 constitute 20% of the population, based on the panel data set we discuss below. This is a slight deviation from the fraction of 17.4% in the Census because we restrict our attention to head of households. We abstract from population growth and the demographic structure remains the same across periods. Every period a measure $\frac{\rho_d \rho_o}{\rho_d + \rho_o}$ of young agents enter the economy to replace the deceased old agents.

We calibrate the annual discount factor β to achieve an aggregate capital output ratio $K/Y = 3.0$ and choose a risk aversion parameter of $\sigma = 3$.

[16] The figure quoted in their paper is 9.9 percent, but this is overhead divided by the total premium, i.e., in the context of our paper where the ϕ are overhead relative to expenditures only, we solve $\phi_I/(1 + \phi_I) = 0.099$ and find $\phi_I = 0.11$.

[17] 15.1% by National Employer Health Insurance Survey of the National Center for Health Statistics in 1993 and 16% by Employer Health Benefits Survey of the Kaiser Family Foundation in 1999.

Total factor productivity A is normalized so that the average labor income, which is \$32,768 in the data, equals one in the benchmark. As is standard in the literature, the capital share α equals 0.33. For the depreciation rate, we pick $\delta = 0.06$.

3.4 Government

Expenditures and taxation: The value for G, that is, the part of government spending not dedicated to social insurance transfers, is exogenously given and it is fixed across all policy experiments. We calibrate it to 18% of GDP in the benchmark economy in order to match the share of government consumption and gross investment excluding transfers, at the federal, state and local levels (The Economic Report of the President, 2004). We set the consumption tax rate τ_c at 5.67%, based on Mendoza, Razin and Tesar (1994).[18]

The income tax function consists of two parts, a non-linear progressive income tax and proportional tax on income. The progressive part mimics the actual income tax in the U.S. following the functional form studied by Gouveia and Strauss (1994), while the proportional part stands in for all other taxes, that is, non-income and non-consumption taxes, which for simplicity we lump together into a single proportional tax τ_y levied on income. The functional form is given as

$$T(y) = a_0 \left\{ y - (y^{-a_1} + a_2)^{-1/a_1} \right\} + \tau_y y. \tag{21}$$

Parameter a_0 is the limit of marginal taxes in the progressive part as income goes to infinity, a_1 determines the curvature of marginal taxes and a_2 is a scaling parameter. To preserve the shape of the tax function estimated by Gouveia and Strauss, we use their parameter estimates $\{a_{0,}a_1\} = \{0.258, 0.768\}$ and choose the scaling parameter a_2 such that the share of government expenditures raised by the progressive part of the tax function $a_0 \left\{ y - (y^{-a_1} + a_2)^{-1/a_1} \right\}$ equals 65%. This matches the fraction of total revenues financed by income tax according to the OECD Revenue Statistics. The parameter a_2 is calibrated within the model because it depends on other endogenous variables. The parameter τ_y in the proportional term is chosen to balance the overall government budget and it, too, will be determined in the model's equilibrium.

Social insurance program: The minimum consumption level $\bar{c}$ to be eligible for social insurance is calibrated so that the model achieves the target share of households with a low level of assets. Households with net worth of less than \$5,000 constitute 20.0% (taken from Kennickell, 2003, averaged over 1989, 1992, 1995, 1998 and 2001 SCF data, in 2001 dollars) and we use this figure as a target to match in the benchmark equilibrium.

Social security system: We set the replacement ratio at 45% based on the study by Whitehouse (2003). In equilibrium, the total benefit payment equals the total social security tax revenues. The social security tax rate is pinned down in the model given that the system is self-financed. We obtain the social security tax rate $\tau_{ss} = 10.61\%$, which (endogenously) matches the current Old-Age and Survivors Insurance (OASI) part of the social security tax rate, 10.6%.

Medicare: We assume every old agent is enrolled in Medicare Part A and Part B. We use the MEPS data to calculate the coverage ratio of Medicare in the five expenditure bins $x_o \in \mathbb{X}_o$.

bin	1	2	3	4	5	6	7
$q_{med}(x)$	0.228	0.285	0.342	0.406	0.511	0.637	0.768

[18] The consumption tax rate is the average over the years 1965-1996. The original paper contains data for the period 1965-1988 and we use an unpublished extension for 1989-1996 for recent data available on Mendoza's webpage.

The Medicare premium for Part B was \$799.20 annually in the year 2004 or about 2.11% of annual GDP (\$37,800 per person in 2004) which is the ratio that we use in the simulations. The Medicare tax rate τ_{med} is determined within the model so that the Medicare system is self-financed. The model generates expenditures and revenues equal to 1.51% of labor income.[19]

4 Numerical results

4.1 Benchmark model

Although we don't calibrate the model to directly target and generate the patterns of health insurance across the dimension of individual states, our model succeeds in matching them fairly well not only qualitatively but in most cases even quantitatively.

The overall health insurance coverage ratio among the young agents is 75.6% as opposed to 73.1% in the data. Figure 1 displays the take-up ratios of the model over the labor income together with the same statistics from the MEPS data. Both in the data and model, the take-up ratios increase in income. If agents are offered group insurance, the take-up ratios are very high since they receive the subsidy from the firm and the tax benefit. As we saw in the calibration section, agents with higher income are more likely to be offered a group insurance and very few agents in the lowest income grid receive such a benefit, which contribute to the lower take-up ratio of low-income agents. Also recall that we capture agents with no labor income and do not impose any income threshold. Many of them also own a low level of assets and are likely to be eligible for the social insurance. In case the agents face a high expenditure shock and can only purchase individual health insurance at a high premium, they may choose to remain uninsured in the hope of receiving the social insurance and having the health cost be covered by the government. At the very low end of the labor income distribution, the take-up ratio is higher in the data than in the model. The fact that people derive income from sources other than the labor and capital as in the model may contribute to the higher coverage.

Figure 2 displays the take-up ratios over the health expenditures. The data shows a fairly flat take-up ratios between 70 and 80% except for the agents with very low expenditures. Our model also generates a flat pattern of take-up ratios, although we are not very successful at the very low end. One possible reason is our assumption that all the employers pay 80% of the premium at the firm level, which is based on the average subsidy ratio in the data. In practice, however, different firms cover a varying fraction of the premium and the data may capture some of those agents with a less generous employer subsidy. The healthiest agents with a relatively low expected expenditure may choose not be insured if the employer subsidy is sufficiently low.

4.2 Policy experiments

We now conduct experiments to determine the effect of changes in the tax treatment of health insurance. In the experiments, we treat changes in the government revenue as follows: expenditures G, consumption tax rate τ_c and the progressive part of the income tax function remain unchanged from the benchmark. We adjust the proportional tax rate τ_y to balance the government budget. Medicare and social security systems remain self-financed and the revenue will also be affected because the labor income, which is the payroll tax base, changes across experiments. We keep the Medicare premium p_{med} (in terms of its ratio to output) at the benchmark level

[19]This figure is lower than in reality (Medicare tax rate 2.9% with its expenditures of about 2.3% of GDP) for two reasons. First, in our model Medicare is reserved exclusively for the old generation while the actual Medicare system pays for certain expenditures even for young agents. Second, payroll taxes apply to all of labor income while in reality there is a threshold level of \$97,500 as of 2007 after which the marginal payroll tax is zero.

and adjust the tax rate τ_{med} to maintain the balance. For the social security system, we keep the replacement ratio at 45% and adjust the retirement benefit ss to account for the changes in the average labor income and the tax rate τ_{ss} to balance the program's budget.

In each experiment, we first compute a steady state outcome under the stationary equilibrium and then the transition dynamics. We assume that in period 0, the economy is in the steady state of the benchmark economy. In period 1, an unanticipated change of the policy is announced and implemented and the economy starts to make a transition to the new steady state. Throughout the transition, the proportional tax rate τ_y as well as payroll taxes τ_{ss} and τ_{med} are adjusted to balance the overall budget of the government, social security and the Medicare systems respectively. Also, the health insurance premium will change as the insurance demand evolves over time.

In order to assess the welfare effect of a reform, once we solve for the transition dynamics, we compute the consumption equivalent variation ("CEV"). It measures the constant increment in percentage of consumption in every state of the world that has to be given to the agent so that he is indifferent between remaining in the benchmark and moving to another economy which is about to make a transition to the new steady state implied by the alternative policy.

4.2.1 Abolishing tax deductibility of group premium costs

The first experiment (experiment A) invokes a radical change - the government abolishes the entire deductibility of the group insurance premium for both income and payroll tax purposes. Consequently, taxes are now collected on the entire portion of the premium, thus the taxable income is

$$y = \tilde{w}z + r(a + T_B) + i_E i'_{HI} \left(\psi p^{bench} + \psi^m \left(p - p^{bench}\right)\right).$$

Note that not only is the employee-paid portion no longer tax-deductible, but also the portion paid by the employer is subject to taxation and considered as part of taxable income of the agent. The policy will eliminate the regressiveness of the system and restore the vertical inequality created by the progressiveness of the income tax function.

We allow supply side effects as a result of policy changes, both on the extensive and intensive margin, i.e. the probability of GHI offers and generosity in terms of the subsidy rate. On the intensive margin we assume that the employer subsidy to GHI adjusts when the premium changes. Specifically, we assume that employers pay ψ^m for every dollar of premium above the benchmark value of p^{bench}. In other words, employers pay a total subsidy worth $\psi p^{bench} + \psi^m \left(p - p^{bench}\right)$. This specification is motivated by the observation that at the margin employers seem to carry a much smaller share of the GHI premium, i.e., $\psi^m < \psi$. This fact has been documented in the literature. For example, Gruber and McKnight (2003) argue that "the key dimension along which employers appear to be adjusting their health insurance spending is through the generosity of what they contribute." Sommers (2005) argues that wage stickiness prevents firms from reducing wages when the premium increases. We use an estimate of $\psi^m = 0.50$. Simon (2005) estimate that the employers pass 75% of the premium hike as increased employee contributions (i.e. only 25% paid by employers), but we regard this estimate of employer contribution is too low given that he looked at small firms only who tend to be less generous with their group insurance subsidy as pointed out by Gruber and Lettau (2004).

For the extensive margin, to gauge the effect on the offer probability we rely on work by Gruber and Lettau (2004) who run a probit model of GHI offers on the tax-price of health insurance, which is defined as the after tax price of one dollar worth of insurance. They estimate that taking away the income and payroll tax subsidy, thereby increasing the tax-price of health insurance to unity, is going to reduce the share of workers that are offered GHI by 15.5 percent (p. 1290, Table 5). We will therefore adjust the transition matrix $\Pi_{Z,E}$ to account for lower offer rates. Specifically, we target a new stationary distribution p_{sd} such that

$$\begin{aligned} p_{sd}(x, i_E = 1) &= 0.845 * p_{sd}^{bench}(x, i_E = 1) \\ p_{sd}(x, i_E = 0) &= 0.155 * p_{sd}^{bench}(x, i_E = 1) + p_{sd}(x, i_E = 0) \end{aligned}$$

where p_{sd}^{bench} is the stationary distribution from the benchmark. This yields the following probabilities (in percent) of being offered insurance

z grid number	1	2	3	4	5	sum
GHI offered: benchmark	3.2	11.2	15.1	16.4	17.3	62.6
GHI offered: no tax subsidy	2.7	9.5	12.8	13.8	14.6	52.9
Change	-15.5%	-15.5%	-15.5%	-15.5%	-15.5%	-15.5%

This ensures that the total share of agents offered group insurance is 15.5 percent lower than in the benchmark, but the distribution of labor productivity is unchanged. How realistic is that to assume that the tax policy change reduces the GHI probability by the same percentage in all income bins? The work by Gruber and Lettau (2004) shows that most of the loss in GHI offers would come from lower income households, thus making the removal of the tax subsidy more regressive than we model. We therefore view the overall welfare loss in our experiment as a lower bound.[20]

Experiment results are summarized in Table 3. The top section displays some statistics on health insurance: the premium of group insurance p, the overall take-up ratio TUR_{all}, the take-up ratio conditional on not being offered group insurance TUR_{noG} and offered group insurance TUR_G. The next two rows *Group* and *Individual* show the break-down of TUR_G, i.e. the fraction of agents who bought group insurance (*Group*) or individual insurance (*Individual*) conditional on being offered group insurance. The second section displays aggregate variables including the proportional tax rate τ_y on income that balances the government budget and the third section shows the welfare effects of each reform. *% w/ CEV > 0* indicates the fraction of young agents in the benchmark that would experience a welfare gain (positive CEV) if the alternative policy is implemented.

Removing the tax subsidy leads to a partial collapse of the group insurance market. The take-up ratio conditional on being offered group insurance falls from 99.0% in the benchmark to 57.4%. About two-thirds of those who remain insured opt out of the group insurance market and purchase a contract in the individual market. Those are agents in better health who face a lower premium in the individual insurance market. The exit of these agents out of the group insurance market triggers a significant deterioration of the health quality in the pool of the insured and the price of the group insurance premium p jumps up to \$5,316 from the benchmark price of \$2,018. The overall coverage ratio falls by as much as 27.3%. An increased exposure to the health expenditure shocks raises the precautionary savings demand and the aggregate capital increases by 0.8% in the steady state. The magnitude of the drop is relatively small given the size of the drop in the coverage, since many agents who become uninsured by declining the group insurance offer are healthy and less concerned about expenditure shocks in the immediate future. The firm's cost of providing the benefit is lower despite the price increase, since much fewer workers take the offer.

Although the wage rate is higher and the proportional tax rate τ_y on income and the social security tax rate τ_{ss} on labor income are lower than in the benchmark due to the increased tax base, they are not enough to compensate for the average welfare loss for the agents with a group insurance offer due to the lower insurance coverage and increased exposure to health expenditure

[20] We conduct sensitivity analysis of our results under alternative assumptions about the supply side reactions. See Appendix B for details.

shocks. Agents without the offer will benefit from the lower tax rate and the slightly higher wage. As shown in *% w/ CEV > 0*, only 20% of workers would experience a welfare gain from such a reform, and the average welfare effect (in CEV) is negative, in the order of 0.34% in terms of consumption in every state.

4.2.2 Other experiments

Experiment B. fixing regressiveness: In this experiment, we let the government correct for regressiveness of the current system and provide the subsidy more equitably. More precisely, the government abolishes the premium deductibility for the income tax purpose while keeping the deductibility for payroll tax, and in exchange returns a lump-sum subsidy for the purchase of group insurance. The subsidy is computed so that the government maintains the budget balance while maintaining the income tax rate τ_y unchanged. The idea is that the government returns the increased revenues due to the abolishment of deductions in the form of a lump-sum subsidy to the agents who purchase insurance through their employers.

Compared to the benchmark, this policy is intended to be more beneficial if the agent with a group insurance offer belongs to a lower income group, because under the benchmark the deduction was based on their lower marginal tax rate. The subsidy based on the average tax rate under this policy is common across agents and higher than the benefit deduction from the lower tax bracket. As shown in the Table 4, the coverage goes up by most among the lowest income people and the welfare is improved, although the magnitude is relatively small.

Experiment C. extending tax deductibility to the non-group insurance market: In the next policy experiment, the government keeps the current tax deductibility for the group insurance premium untouched and aims to correct for the horizontal equity by providing some benefit for the individual insurance market. One way to do it is to extend the same tax advantage to everyone, i.e. agents who purchase a contract in the individual market can also deduct the premium cost from their income and payroll tax bases. As shown in the top section of Table 4, the policy would increase the insurance coverage among the people without an access to the group insurance market by more than 38% and the overall coverage by 14%. An increased cost of providing deduction is reflected in the proportional tax rate τ_y and the social security tax rate τ_{ss} that are higher than in the benchmark. An increased coverage across the different health status will reduce the precautionary savings and the aggregate capital falls by about 0.7%.

In terms of welfare, the policy brings some welfare gain for those without an insurance offer from the employer. Despite the decrease in the aggregate consumption in the final steady state, the reform will enable agents to smooth consumption across the states and enhances the overall welfare. The number of agents who are eligible for the social insurance goes down by 1.5%, since agents are better insured and less exposed to a catastrophic health shock that would bring their disposable assets down to hit the minimum consumption level $\bar{c}$.

Experiment D. providing credit to the non-group insurance market: In experiments D-1 and D-2, the government offers a refundable credit of $1,000 for the purchase of individual insurance, if the person is not offered group insurance. The subsidy is capped by the actual cost of insurance. In experiment D-2, the provision of the subsidy is subject to the income threshold of $30,000, above which the subsidy phases out. As shown in Table 4, there is a large effect on the insurance coverage among those without an access to group insurance. The conditional take-up ratio increases from 36% to 87% and 76%, respectively.

The comparison of the results in experiments D-1 and D-2 poses a question of costs and efficiency in targeting beneficiaries. By restricting the eligibility to the lower income households in experiment D-2, the required increase in the proportional tax rate τ_y is 0.42% as opposed to 0.65% in D-1. The policy increases the overall TUR by 15% and 19%. It becomes more costly to provide an incentive to be insured if the agent's income is higher. Wealthy households with more assets are better insured by their accumulated savings. Although not imposing any restrictions on the target beneficiaries of the subsidy may be easier to implement both politically and operationally, such a choice has to be balanced against efficiency.

At the bottom of Table 4, we display the take-up ratios across income shocks z and health expenditure shocks x. In experiment D-1, compared to C, there is much larger increase of the take-up ratios among lower-income households. Providing a subsidy as in D-1 and D-2 is more effective than a tax deduction because low-income agents do not pay much tax. Therefore, they receive only small benefits from the deduction policy. The credit policy D-2 also works effectively to raise the coverage among the poor, while the coverage among the rich changes little due to the phase-out of the benefit at a high income level. As shown in the take-up ratios over the expenditure shocks x, both credit policies encourage the purchase among healthier agents, since they face a lower premium cost, the large part of which can be covered by the subsidy.

Increased risk-sharing together with the higher tax rate reduce the saving motive and the aggregate capital and output are lower in both D-1 and D-2. Despite the increased tax burden and the relatively large fall in the aggregate level of consumption, the gains from the better insurance coverage and an increased protection against expenditure shocks dominate the negative effects and the welfare effect among young agents is positive on average with a CEV of 0.58% and 0.55% in the two experiments. The number of agents eligible for the social insurance goes down by 3.03 to 2.87% in the reforms. The vast majority of the agents would support such reform proposals.

5 Conclusion

We study the tax policy associated with employer-provided health insurance in a general equilibrium model, where the health insurance decision is endogenous. The model captures various institutions surrounding the different types of health insurance in a parsimonious way, yet it is rich enough to generate insurance demand that closely resembles that observed in the data. We examine the effects of several tax reforms. The experiments indicate that despite some issues entailed in the current tax system, providing some form of subsidy and an incentive for the group insurance coverage has a merit. Employer-provided group insurance has the feature that everyone can purchase a contract at the same premium irrespective of any individual characteristics - most importantly it is independent of current health status. Relatively healthy agents would have an incentive to opt out of this contract and either self-insure or find a cheaper insurance contract in the individual market. A subsidy on group insurance can therefore encourage even healthy agents to sign up, maintain the diverse health quality of the insurance pool and alleviate the adverse selection problem that could plague the group insurance contract. We conduct an experiment that confirms this intuition by showing that a complete removal of the subsidy results in the deterioration of health quality in the group insurance market, a rise in the group insurance premium, a significant reduction in the insurance coverage, which put together reduces the average welfare.

We also find that there is room for significantly increasing the insurance coverage and improving welfare by restructuring the current subsidy system. Extending the benefit to the individual insurance market to restore horizontal equity is effective in raising the overall insurance coverage and enhancing welfare if the subsidy is lump-sum. Extending the deductions to the individual insurance on the other hand is less effective since low income households will receive less benefit from such a reform. Providing a refundable credit for the purchase of individual insurance is shown to raise the coverage by about 20% and enhance the welfare despite the increase in the tax to finance the additional expenditures of the government.

Our work highlights the importance of studying health policy and insurance in a general equilibrium framework. Equilibrium prices and aggregate variables are affected by changes in policy. For example, changing the tax treatment of health insurance premia affects the composition of agents that sign up and therefore the equilibrium insurance premium. Altering the attractiveness of health insurance also affects precautionary saving motives, which in turn determines factor prices such as wages and interest rates. We have also shown that it is important to capture fiscal consequences of a reform because providing the subsidy will affect the taxes that must be raised from other sources. The changes in insurance demand are shown to affect other government sponsored welfare programs such as Medicaid.

We compute the transition dynamics from the benchmark economy calibrated to the current macroeconomic and institutional environments surrounding the health insurance policies. Since our focus was on the effect of the tax policy, we chose not to alter other institutions and features of the model along the transition. An interesting question as an extension of the current paper will be to ask how agents' insurance and saving decisions as well as the government's fiscal balance will be affected in response to the future changes in those environment, in particular, the rapidly rising health costs and changing demographics. Also, a rather radical policy reform will be the introduction of the national health system. We will leave these subjects to a future and ongoing research.

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Appendix

A Data and calibration details

Additional details regarding the calibration of endowment, health insurance and expenditure processes are as follows.

A.1 Selection of individuals

The MEPS database does not explicitly identify a head of household, but rather one reference person per dwelling unit, usually the owner or renter. If more than one person owns/rents the unit then the interviewer picks *exactly* one of them. Unfortunately, the definition of one household in the model as one dwelling unit in the data is inappropriate for our purposes. This is because if multiple households live in one single dwelling unit we may miss a large fraction of the population. This happens if roommates share a unit, in which case we want to capture each person as a separate economic unit. Another example would be adult children living with their parents, where we want to capture the parents and the child as separate economic units.

Our definition of a household, therefore, is based on the Health Insurance Eligibility Unit (HIEU) defined in the MEPS database. A HIEU is a unit that includes adults and other family members who are eligible for coverage under family insurance plans. Thus, each dwelling unit is composed of potentially multiple HIEUs. A HIEU includes spouses, unmarried natural or adoptive children of age 18 or under and children under 24 who are full-time students. The definition of a head is the single adult member in case of an unmarried couple. For a household with a married couple, we choose the one with a higher income as the head of the households. We tried other definitions as head of households, for example the oldest adult, but the calibration results did not change materially.

MEPS also provides the longitudinal weight for each individual which we use to compute all of the statistics in our calibration, i.e., all moments are weighted by the MEPS weight. Finally, we call agents aged 20-64 'young' and those age 65+ 'old'.

Next, we stack individuals in the five different panels into one large data set, of course converting all nominal values into dollars of the base year 2003. Ho do we handle the longitudinal weights? For each panel we rescale the weights such that sum of the weights in that panel is equal to the number of heads of households age 20 and older. That way within each panel people get a weight proportional to their longitudinal weights, and each panel gets a weight proportional to the number of heads of household in the age groups we consider.

Table 1: Number of observations in the five panels

Panel	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004	Total
Individuals	6,099	4,839	9,863	7,381	7,612	35,794

A.2 Transition matrices

A.2.1 Income and health insurance offer

MEPS records annual wage income, for example, variable WAGEPyyX stands for income in the year yy$\in \{99, 00, 01, 02, 03, 04\}$. We keep all individuals in the sample, regardless of income. Specifically, even those with zero income stay in our sample and account for almost 9 percent of the young generation. MEPS also records whether a person is offered health insurance at the workplace (variables OFFER31X, OFFER42X and OFFER53X). The three variables refer to three subperiods each year in which interviews were conducted. We assume that an individual was offered insurance if he or she got an offer in at least one subperiod.

Constructing the transition matrix is then simply summing up the longitudinal weights of individuals that jump from one of the $N_z \times 2$ bins in the first year into the $N_z \times 2$ bins in the second year. We also compute stationary distributions as well as the average income in each of the N_z bins to use it as the income grid point in our Markov process.

The transition matrix for the income z and group insurance offer status i_E is as follows. Entries 1 to 5 from the top are the income bins 1 to 5 with employer-based insurance and entries 6 to 10 are the five income groups without insurance offered. For example, $\Pi_{Z,E}(7,3) = 0.038$ implies that given the agent has income $z = 2$ and no group insurance offer this period, the probability of having income $z = 3$ and a group insurance offer in the next period is 3.8%, conditional on not aging tomorrow.

$$\Pi_{Z,E} = \left[\begin{array}{ccccc|ccccc}
0.201 & 0.312 & 0.110 & 0.065 & 0.046 & 0.165 & 0.074 & 0.019 & 0.005 & 0.002 \\
0.068 & 0.439 & 0.252 & 0.079 & 0.018 & 0.051 & 0.065 & 0.022 & 0.008 & 0.002 \\
0.024 & 0.122 & 0.489 & 0.240 & 0.052 & 0.015 & 0.019 & 0.024 & 0.013 & 0.002 \\
0.012 & 0.060 & 0.152 & 0.527 & 0.187 & 0.011 & 0.008 & 0.010 & 0.022 & 0.011 \\
0.009 & 0.025 & 0.048 & 0.134 & 0.724 & 0.009 & 0.004 & 0.008 & 0.008 & 0.030 \\
\hline
0.042 & 0.045 & 0.013 & 0.007 & 0.003 & 0.715 & 0.124 & 0.033 & 0.013 & 0.005 \\
0.025 & 0.119 & 0.038 & 0.022 & 0.004 & 0.219 & 0.373 & 0.136 & 0.040 & 0.025 \\
0.010 & 0.044 & 0.098 & 0.035 & 0.014 & 0.140 & 0.202 & 0.286 & 0.126 & 0.046 \\
0.008 & 0.018 & 0.034 & 0.075 & 0.029 & 0.099 & 0.137 & 0.158 & 0.306 & 0.136 \\
0.010 & 0.017 & 0.008 & 0.013 & 0.070 & 0.088 & 0.100 & 0.094 & 0.170 & 0.430
\end{array}\right]$$

A.2.2 Health Expenditure Shocks

MEPS reports total health expenditures as well as a breakdown into different sources of payment. Expenditures refer to the amount actually *paid* as opposed to the amount *charged* by providers. See AHRQ (2003), p. C-101, for details. We disregard medical expenditures paid for by Veteran's Affairs (TOTVAyy), Workman's Compensation (TOTWCPyy) and other sources (TOTOSRyy). Summing up the remaining categories gives us the total medical expenditures considered in our model.

As before, we assign expenditures in both years into their respective percentiles and sum up the weights of agents that move from one of the N_x bins in the first year into the N_x bins in the second year. We compute the stationary distribution as well as average expenditures for the bins and the stationary distributions. The transition matrices for the health expenditures shocks x_y for young and x_o for old are given as follows.

$$\Pi_{x_y} = \begin{bmatrix} 0.542 & 0.243 & 0.113 & 0.061 & 0.032 & 0.007 & 0.002 \\ 0.243 & 0.330 & 0.242 & 0.117 & 0.056 & 0.011 & 0.001 \\ 0.119 & 0.224 & 0.296 & 0.232 & 0.098 & 0.025 & 0.006 \\ 0.058 & 0.130 & 0.225 & 0.347 & 0.201 & 0.035 & 0.005 \\ 0.043 & 0.079 & 0.140 & 0.263 & 0.371 & 0.090 & 0.014 \\ 0.030 & 0.063 & 0.080 & 0.203 & 0.359 & 0.200 & 0.065 \\ 0.008 & 0.024 & 0.073 & 0.106 & 0.269 & 0.286 & 0.233 \end{bmatrix}$$

$$\Pi_{x_o} = \begin{bmatrix} 0.654 & 0.165 & 0.075 & 0.055 & 0.042 & 0.009 & 0.001 \\ 0.191 & 0.385 & 0.199 & 0.126 & 0.075 & 0.021 & 0.003 \\ 0.071 & 0.222 & 0.323 & 0.217 & 0.135 & 0.026 & 0.005 \\ 0.057 & 0.146 & 0.249 & 0.311 & 0.184 & 0.041 & 0.013 \\ 0.027 & 0.084 & 0.173 & 0.318 & 0.292 & 0.083 & 0.024 \\ 0.026 & 0.090 & 0.102 & 0.216 & 0.375 & 0.137 & 0.054 \\ 0.044 & 0.027 & 0.047 & 0.217 & 0.391 & 0.264 & 0.010 \end{bmatrix}$$

A.3 Takeup ratios

MEPS records whether an individual who offered group insurance through the workplace actually signs up for it (variables HELD31X, HELD42X and HELD53X). As with the offer variables we assume that a person signed up he or she did so in at least one subperiod. We also have data on whether an individual had any kind of private insurance (GHI or IHI) during the year (variable PRVEVyy=1, where yy$\in \{99, 00, 01, 02, 03, 04\}$). We assume those who were not offered GHI but who hold private insurance, are in the IHI contract. If a person is offered GHI, did not accept it, but still holds private insurance, we assume that he or she is covered by IHI.

A.4 Calibration of the health insurance coverage ratio $q(x)$

We compute the coverage ratios of private insurance for young agents and Medicare for old agents. We use a polynomial of the following form:

$$q = \beta_0 + \beta_1 \log(x) + \beta_2 (\log x)^2,$$

where x is the total health expenditures in US dollars and q corresponds to the coverage ratio of private health insurance for young agents and Medicare coverage ratio for old agents. We consider only agents with positive expenditures in this regression. For the young generation we also restrict our attention to those that actually have private insurance (variable PRVEVyy=1). We use weighted least squares to find the following estimates, where the standard errors in brackets and all coefficient estimates are significant at the 1 percent level:

	q	q_{med}
β_0	0.3410	0.5749
	(0.0207)	(0.0230)
β_1	0.0291	-0.1392
	(0.0062)	(0.0061)
β_2	0.0016	0.0139
	(0.0005)	(0.0004)
R^2	0.2510	0.3946

We plug in the N_x grid points to attain the coverage ratio for each bin. We find

bin	1	2	3	4	5	6	7
$q(x)$	0.341	0.532	0.594	0.645	0.702	0.765	0.845
$q_m(x)$	0.228	0.285	0.342	0.406	0.511	0.637	0.768

B Robustness analysis

In experiment A, where the tax policy is completely eliminated, we allowed the firms to react in both extensive and intensive margin. In this section, we present results under the alternative assumptions about the supply side reactions.

Table 5 summarizes the results. The first column next to the benchmark and the baseline experiment is the experiment *(I) no adj.*, in which we eliminate the tax policy but assume that the firms do not adjust either intensive or extensive margin. The firms continue to pay 80% of the premium as a subsidy no matter what the price hike is and the offer probability is not affected. In the experiment *(ii) ext.* and *(iii) int.*, we adjust only the extensive and intensive margin respectively. Across the alternatives, the elimination of the policy triggers a partial collapse of the group health insurance market, making the healthy agents leave the pool. The downward adjustment of the firm's subsidy in response to the premium increase will raise the agents' marginal price of an insurance contract and induces more agents to become uninsured. The negative welfare effect of the policy change is robust across experiments under alternative specifications and it is sizeable even under an extreme assumption of no adjustment at all.

Table 2: Parameters of the model

Parameter	Description	Values
Preferences		
β	discount factor	0.934
σ	relative risk aversion	3.0
Technology and production		
α	capital share	0.33
δ	depreciation rate of capital	0.06
Government		
$\{a_0, a_1, a_2\}$	income tax parameters (progressive part)	{0.258,0.768,0.716}
τ_y	income tax parameter (proportional part)	4.456%
$\bar{c}$	social insurance minimum consumption	23.9% of average labor income
τ_{ss}	social security tax rate	10.61%
	Social security replacement ratio	45%
$q_{med}(x)$	Medicare coverage ratio	see text
τ_{med}	Medicare tax rate	1.51%
p_{med}	Medicare premium	2.11% of per capita output
Demographics		
ρ_o	aging probability	2.22%
ρ_d	death probability after retirement	8.89%
Individual health insurance		
$q(x)$	coverage ratio	see text
p	group insurance premium	6.2% of average income ($2,018)
ψ	group insurance premium covered by a firm (%)	80%
ϕ	premium mark-up (operational cost)	11%

Table 3: Experiment A: abolishing deductibility of group insurance premium from income and payroll income tax bases

	Benchmark	A
p	\$2,018	\$5,316
TUR_{all}	75.67%	48.35%
TUR_{noG}	35.54%	38.00%
TUR_G	99.04%	57.38%
Group	99.04%	17.56%
Individual	0.00%	39.82%
Agg. output	1.0000	1.0027
Agg. capital	1.0000	1.0081
Agg. consumption	1.0000	1.0038
Interest rate	4.993%	4.934%
Wage rate (w)	1.0000	1.0027
Offer cost (c_E)	1.0000	0.3585
Avg Labor Inc	1.0000	1.0236
τ_y	4.456%	3.742%
τ_{ss}	10.607%	10.531%
τ_{med}	1.505%	1.458%
Social ins. covered	1.0000	1.0328
CEV from transition		
all (young)	-	-0.335%
young w/ GHI offer	-	-0.462%
young w/o GHI offer	-	-0.118%
$\%w/CEV > 0$ (young)	-	19.20%

TUR by z		
z_1	32.34%	25.02%
z_2	70.74%	42.72%
z_3	88.44%	64.97%
z_4	93.60%	60.58%
z_5	94.62%	49.12%
TUR by x		
x_1	76.70%	50.88%
x_2	75.03%	45.40%
x_3	75.05%	44.69%
x_4	75.17%	46.13%
x_5	76.16%	53.09%
x_6	76.83%	58.45%
x_7	77.14%	63.14%

Figure 1: Take-up ratios over income z (model and data)

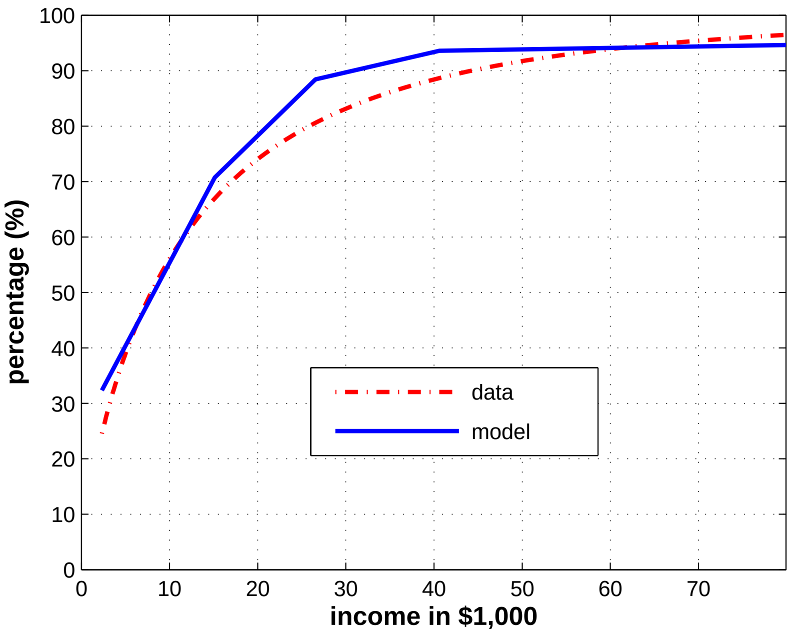

Figure 2: Take-up ratios over expenditures x_y (model and data)

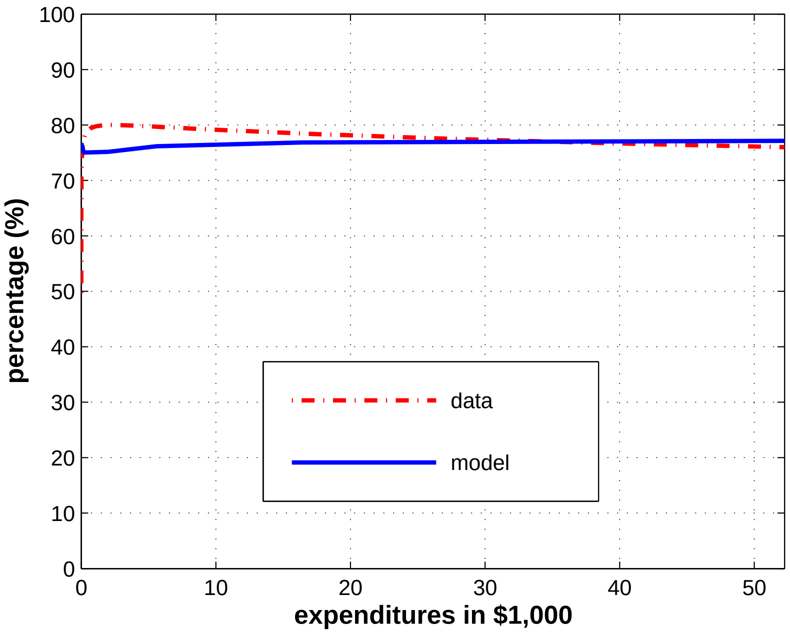

Table 4: Other experiments

	Benchmark	B	C	D-1	D-2
p	\$2,018	\$2,013	\$2,017	\$2,016	\$2,016
TUR_{all}	75.67%	75.98%	89.76%	94.52%	90.47%
TUR_{noG}	35.54%	35.44%	73.81%	86.74%	75.74%
TUR_G	99.04%	99.60%	99.04%	99.06%	99.06%
Group	99.04%	99.60%	99.04%	99.06%	99.06%
Individual	0.00%	0.00%	0.00%	0.00%	0.00%
Agg. output	1.0000	0.9991	0.9977	0.9941	0.9947
Agg. capital	1.0000	0.9971	0.9931	0.9823	0.9841
Agg. consumption	1.0000	0.9991	0.9973	0.9938	0.9949
Interest rate	4.993%	5.015%	5.045%	5.126%	5.112%
Wage rate (w)	1.0000	0.9991	0.9977	0.9941	0.9947
Offer cost (c_E)	1.0000	1.0029	0.9995	0.9990	0.9990
Avg Labor Inc	1.0000	0.9989	0.9972	0.9939	0.9945
τ_y	4.456%	4.456%	4.722%	5.106%	4.873%
τ_{ss}	10.607%	10.607%	10.680%	10.607%	10.607%
τ_{med}	1.505%	1.507%	1.521%	1.518%	1.517%
Social ins. covered	1.0000	1.0009	0.9854	0.9697	0.9713
CEV from transition					
all (young)	-	0.073%	0.241%	0.583%	0.554%
young w/ GHI offer	-	0.062%	0.159%	0.371%	0.387%
young w/o GHI offer	-	0.092%	0.381%	0.946%	0.840%
$\%w/CEV > 0$ (young)	-	79.90%	79.79%	99.25%	99.86%
TUR by z					
z_1	32.34%	33.95%	57.22%	77.41%	77.18%
z_2	70.74%	70.70%	93.47%	96.59%	92.78%
z_3	88.44%	88.43%	99.44%	99.39%	94.31%
z_4	93.60%	93.53%	99.88%	99.89%	93.79%
z_5	94.62%	94.64%	99.97%	99.98%	94.81%
TUR by x					
x_1	76.70%	77.03%	90.07%	97.57%	93.94%
x_2	75.03%	75.45%	90.24%	96.18%	91.94%
x_3	75.05%	75.44%	90.08%	94.58%	90.26%
x_4	75.17%	75.42%	89.70%	92.89%	88.57%
x_5	76.16%	76.31%	88.96%	91.37%	87.40%
x_6	76.83%	76.96%	87.88%	89.84%	86.53%
x_7	77.14%	77.25%	86.28%	87.74%	85.35%

B: abolish group insurance deductibility from income tax base and provide credit for group insurance at the average income tax rate
C: extend the same deduction for the purchase of individual insurance
D-1: provide credit of \$1,000 for the purchase of individual insurance if no access to group insurance
D-2: same as D-1 but the subsidy is subject to annual income < \$30,000

Table 5: Robustness analysis of experiment A

	Benchmark	A Baseline	(i) no adj.	(ii) ext.	(iii) int
p	\$2,018	\$5,316	\$3,029	\$3,028	\$5,317
TUR_{all}	75.67%	48.35%	60.90%	58.34%	48.58%
TUR_{noG}	35.54%	38.00%	35.78%	37.32%	36.08%
TUR_G	99.04%	57.38%	75.52%	76.69%	55.86%
Group	99.04%	17.56%	55.07%	55.01%	17.57%
Individual	0.00%	39.82%	20.46%	21.68%	39.29%
Agg. output	1.0000	1.0027	1.0017	1.0020	1.0026
Agg. capital	1.0000	1.0081	1.0053	1.0060	1.0078
Agg. consumption	1.0000	1.0038	1.0023	1.0027	1.0035
Interest rate	4.993%	4.934%	4.954%	4.950%	4.937%
Wage rate (w)	1.0000	1.0027	1.0018	1.0020	1.0026
Offer cost (c_E)	1.0000	0.3585	0.8345	0.8332	0.3585
Avg Labor Inc	1.0000	1.0236	1.0076	1.0115	1.0219
τ_y	4.456%	3.742%	3.752%	3.754%	3.741%
τ_{ss}	10.607%	10.531%	10.454%	10.473%	10.523%
τ_{med}	1.505%	1.458%	1.471%	1.468%	1.459%
Social ins. covered	1.0000	1.0328	1.0091	1.0203	1.0259
CEV from transition					
all (young)	-	-0.335%	-0.162%	-0.205%	-0.342%
young w/ GHI offer	-	-0.462%	-0.244%	-0.297%	-0.468%
young w/o GHI offer	-	-0.118%	-0.022%	-0.046%	-0.124%
$\%w/CEV > 0$ (young)	-	29.93%	23.93%	19.49%	19.20%

TUR by z					
z_1	32.34%	25.02%	28.58%	27.00%	26.09%
z_2	70.74%	42.72%	53.67%	51.23%	42.72%
z_3	88.44%	64.97%	74.79%	73.58%	63.75%
z_4	93.60%	60.58%	77.06%	73.56%	61.37%
z_5	94.62%	49.12%	71.32%	67.26%	49.60%
TUR by x					
x_1	76.70%	50.88%	52.84%	53.27%	50.52%
x_2	75.03%	45.40%	54.45%	53.05%	45.08%
x_3	75.05%	44.69%	60.91%	57.76%	44.55%
x_4	75.17%	46.13%	67.25%	62.73%	46.56%
x_5	76.16%	53.09%	70.10%	65.24%	54.93%
x_6	76.83%	58.45%	71.32%	67.50%	59.91%
x_7	77.14%	63.14%	72.32%	69.98%	63.52%