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Health Insurance and Tax Policy

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Abstract: The U.S. tax policy on health insurance favors only those offered a group insurance through their employers. This policy is highly regressive since the subsidy takes the form of deductions from the progressive tax system. The paper investigates alternatives to the current policy. We find that the complete removal of the subsidy results in a significant reduction in the insurance coverage and serious welfare deterioration. However, eliminating regressiveness in the group insurance subsidy and extending benefits to the private insurance market improve welfare and raise the coverage. Our work is the first in highlighting the importance of studying health policy in a general equilibrium framework with an endogenous demand for the health insurance. We use the Medical Expenditure Panel Survey (MEPS) to calibrate the process for income, health expenditure shocks, and health insurance offer status and succeed in producing the pattern of insurance demand as observed in the data, which serve as a solid benchmark for the policy experiments.

JEL classification: E21, E62, I10

Key words: health insurance, risk sharing, tax policy

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1 Introduction

The aim of this paper is to study the effects of tax policy on the health insurance decision of households in a general equilibrium framework with heterogenous agents. Motivating the economic importance of health care and health insurance poses no difficulty. Both in absolute and relative terms Americans spend a sizeable amount of resources on health care. According to the Bureau of Economic Analysis (BEA), health care expenditures account for 11.9% of GDP in 2004, more than housing services (10.6%), food (9.8%) or durable goods consumption (8.5%).[1] In absolute terms, an average American spends about the $4,887 on health care. At the same time a record number of 45 million people or 15% of the population lack health insurance.

Not surprisingly, the government is actively involved in the health insurance market through government-run medical programs and the tax policy. In 2003 Medicare and Medicaid combined spent $420 billion, almost 4% of GDP. A lesser-known health policy is an estimated $140 billion a year government subsidy in the form of tax-deductibility of employer-provided health insurance.[2] The origin of this policy lies in the price and wage controls in the U.S. during the World War II when companies used the employer-provided health benefits to compete for workers that were in short supply, thereby circumventing the wage controls. Even after the price and wage controls were lifted employers kept providing health plans because they could be financed with pre-tax income. The tax deductibility was extended to health insurance premiums of self-employed individuals more recently.

We set up a general equilibrium model to evaluate the merits of the tax-deductibility of health insurance. We investigate two main issues about the current U.S. tax policy on health insurance. First, the policy is regressive with the progressive income tax and fails to provide vertical equity across different income groups. Second, the tax benefits are limited to the group insurance market and fails to satisfy horizontal equity depending on the offer status of group insurance.

To see the first point of regressiveness, imagine that person A has low productivity, worth $20,000 of annual labor services putting him in the 15% tax bracket, while person B has high productivity, worth $1,000,000 of labor services putting him in the 35% tax bracket. Moreover, a health insurance plan costs $5,000. Assume that initially employees pay for the health insurance plan with after-tax money. If we then introduce tax-deductibility of the insurance premium person A will save $750 and person B will save $1,750, that is, the already well-off person gains more from the tax subsidy. From a risk-sharing point of view this regressive policy is detrimental to welfare and our paper attempts to set up a general equilibrium model to assess the welfare costs of this policy. Our results indicate that keeping the subsidy in place but making it less regressive indeed increases welfare. However, we find that removing the tax subsidy completely would decrease welfare substantially. To restore the second issue of horizontal equity, there are many paths the government could take. Various reform proposals are being intensely debated in the policy arena, such as extending the deductibility to the non-group insurance market or

[1] OECD reports health care expenditures are 13.9% of GDP(in 2001), which also include pharmaceutical spending.

[2] Figures from Gruber (2004).

providing a subsidy for any insurance purchase. We simulate such reforms and find they are in fact effective in raising the insurance coverage and improving welfare.

While there exists a large literature on health, to our knowledge we are the first to set up a model in the tradition of Aiyagari (1994) with endogenous health insurance decision. Health expenditure shocks have been found to be very helpful in adding realism to Aiyagari-type models. For example according to Livshits, MacGee and Tertilt (2003), 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. What is common to 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 is exogenous.

Kotlikoff (1989) builds an overlapping generations model where households face idiosyncratic health shocks (but have no earnings uncertainty) and studies the accumulation of precautionary savings under different insurance schemes, such as self-payment, insurance, or Medicaid. Our model is an improvement in the sense that we don't need separate models for different insurance schemes but instead combine all three of them into one model and let households decide how they want to deal with health expenditure shocks.

Gruber (2004) measures the effects of different subsidy policies for the non-group insurance on the fraction of uninsured by employing a micro-simulation model that relies on reduced-form decision rules for households.

Our micro-funded framework has advantages over many existing works that approach the problem using reduced-form decision rules in that we can compare welfare between policy experiments rather than the measure of the insured. Moreover, we can take into account important general equilibrium effects. For example, changing the tax treatment of health insurance premiums will change savings behavior (and thus the aggregate capital stock and factor prices) directly through marginal taxes as well as indirectly because the lack of health insurance drives precautionary savings motives. It is also important to assess the fiscal consequences of policy reforms. For example, expanding the subsidy may require a higher tax rate on other sources of income in exchange and cause distortions in other sectors, or alter the demand for other social welfare programs such as Medicaid. It is hard to perform all these with reduced form decision rules.

The paper proceeds as follows. Section 2 introduces the model. Section 3 details the parameterizations of the model. Some parameters will be estimated with the model by matching moments from the data. 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, young and old. Young people supply labor and earn the market wage. Old agents are retired from market work and receive Social Security benefits. The young become old with probability ρ_o every period and the old die with probability ρ_d. We assume the population remains constant. The 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 and a fraction of $\frac{\rho_o}{\rho_d+\rho_o}$ of old people. All bequests are accidental 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 market wage w, and it is given as wz. 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. Agents start with zero assets in the initial period.

2.3 Health and health insurance

In each period, agents face an idiosyncratic health expenditure shock x. It represents the required cost to restore the health status back to h, which depends on the age (young or old).

Young agents have access to an insurance market, where they can purchase a contract that would cover a fraction $q(x)$ of the medical cost x. Therefore, with the health insurance contract, the net cost of restoring 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 will see later in the calibration, q increases in x most likely due to deductibles. Obviously agents must decide whether to be covered by insurance before they find out what their expenditure shock is.

If a young agent purchases health insurance through his employer, which we also call group health insurance, a constant premium p must be paid to an insurance company in the year of the coverage. We also allow for 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 $(1 - \psi)\, p$.

Agents that are not offered health benefits through their employer can purchase insurance, too. We call this private health insurance as a opposed to group health insurance through an employer. There are a number of important features in the private insurance market, such as adverse selection, exclusion of preexisting conditions or less generous benefits in private health insurance that are not included in our model. Instead, we assume that the premium paid outside of an employer-paid plan is $p_m(x)$.

The probability of being offered health insurance at work and labor productivity z evolve jointly with a finite-state Markov process. As we discuss more in the calibration section, we do this because the 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 conditional upon the income shocks. The transition matrix is defined as $\Pi_{Z,E}$ of 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 an employer-based health insurance and 0 otherwise.

We assume that all retired agents are enrolled in a 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.

For young agents, health expenditures x follow a finite-state Markov process drawn from a set $\mathbb{X}_y = \{x_{y,1}, x_{y,2}, ..., x_{y,N_{xy}}\}$, with probability $p_{x_y}(x_y, x'_y) = prob(x_{y,t+1} = x'_y | x_{y,t} = x_y)$. The process for old agents are similarly defined with a different subscript. Newly born young agents draw an expenditures shock x from the stationary distribution over the set $\mathbb{X}_y$. When the young become old, they make 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 as young.[3]

2.4 Preferences

Following earlier research by Kotlikoff (1989), we assume that health enters the utility function in a multiplicative way.

$$u_j(c) = h_j \frac{c^{1-\sigma} - 1}{1 - \sigma}, \ \ j = y \text{ (young) or } o \text{ (old)},$$

where c is consumption and h_j is the health status for the young or the old, that determines the marginal utility from consumption. Grossman (1972) treats health as an endogenous variable much like a durable good that can depreciate, but can also be restored to any desired level. Currently the h_y, h_o are given exogenously, so one could interpret our model as a Grossman model where health depreciates but it has to be restored back to the level h_j which will incur a health expenditure x. Therefore, the h_j have only one function in the current version of the paper, namely to create more realistic life-cycle consumption patterns. We might endogenize the h decision in future versions of our paper.

Agents discount future utility by a constant subjective discount factor β.

[3] This assumption requires the sets $\mathbb{X}_y$ and $\mathbb{X}_o$ to have the same number of elements, as we do in calibration.

2.5 Firms and production technology

A representative competitive firm operates the CRS technology. The aggregate output is given as

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

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.

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.[4] 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

$$c_E = \mu_E^{ins} p\psi \frac{1}{\sum_j z_j \bar{p}_{Z,E}(j|i_E = 1)}, \tag{3}$$

where μ_E^{ins} is the fraction of workers that purchase health insurance, conditional on being offered employer-based health insurance benefits, i.e. $i_E = 1$.[5] $\bar{p}_{Z,E}(j|i_E = 1)$ is the stationary probability of drawing productivity z_j conditional on $i_E = 1$.[6]

2.6 The government

We impose balanced budget every period. The Social Security and Medicare systems are self-financed. Both Medicare and Social Security charge proportional taxes τ_{med} and τ_{ss} on labor income and therefore, total payroll taxes as a function of labor income wz are given as $(\tau_{med} + \tau_{ss})wz$.

The government levies tax on income and consumption to finance expenditures G and 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. More details on the tax system are provided in the calibration section.

[4] The assumption behind this wage setting rule is that a firm does not observe states of a worker (a, z, x and i) and does not adjust salary according to them. A firm simply employs efficiency units 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.

[5] It is computed as $\mu_E^{ins} = \sum_s \mu(s|j = y, i_{HI} = 1, i_E = 1) / \sum_s \mu(s|j = y, i_E = 1)$.

[6] It is easy to verify 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).

Social Insurance 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 household's disposable assets fall below $\bar{c}$. This Social Insurance program stands in for Medicaid, Food Stamp Program and all other social assistance programs. We will discuss the mechanism more in detail in the households' problem.

2.7 Households

The state for a young agent is summarized as 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 last period that has to be paid in the current period, i_{HI} is an indicator function that takes a value 1 if the agent held health insurance in the last period and 0 otherwise. i_E is another indicator function for availability of employer-based health insurance benefits in the current period.

The timing of events is as follows. The 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 made all decisions this period's health expenditure shock x' and next period's productivity and offer status are revealed. Together with the policies a' and i'_{HI} they form next period's state $s'_y = (a', z', x', i'_{HI}, i'_E)$. Notice that our setup makes sure that 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 the year before payment occurs. We therefore assume that the insurance company earns interest on the premium for one period.

Since the health insurance contracts for young workers and retirees differ and agents pay their health care bills with a one period lag we have to distinguish between new and existing old people. A recent retiree which we call 'recently aged' has to pay the health care bill of his last year as a young agent, potentially covered by an insurance contract for young agents, while an existing old person was covered by Medicare and potentially supplemental health insurance last period. As a result, the state for recently aged agents is given as $s_r = (a, x, i_{HI})$ and for old agents $s_o = (a, x)$.

We are now ready to define the maximization problems of all three types of agents in recursive form. In the value functions the subscript denotes the type of agent, where y stands for young agents, r stands for recently aged and o refers to existing old agents:

Young's problem

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

subject to

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

where

$$Tax = T(y)+0.5(\tau_{med}+\tau_{ss})(\tilde{w}z-i_E\cdot\tilde{p}) \qquad (6)$$

$$y = \max\{\tilde{w}z+r(a+T_B)-i_E\cdot\tilde{p},0\} \qquad (7)$$

$$T_{SI} = \max\{0,(1+\tau_c)\bar{c}+(1-i_{HI}\cdot q(x))\,x+T(\tilde{y})\;-\tilde{w}z-(1+r)(a+T_B)\} \qquad (8)$$

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

$$\tilde{w} = \begin{cases}(1-0.5(\tau_{med}+\tau_{ss}))\,w & \text{if } i_E=0\\ (1-0.5(\tau_{med}+\tau_{ss}))\,(w-c_E) & \text{if } i_E=1\end{cases} \qquad (9)$$

$$\tilde{p} = \begin{cases}p\cdot(1-\psi) & \text{if } i'_{HI}=1 \text{ and } i_E=1\\ p_m(x) & \text{if } i'_{HI}=1 \text{ and } i_E=0\\ 0 & \text{if } i'_{HI}=0\end{cases} \qquad (10)$$

The young agents' choice variables are (c,a',i'_{HI}), where c is consumption, a' is savings and i'_{HI} is the indicator variable for the 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.

With probability $(1-\rho_o)$ the agent remains young in the next period and with probability ρ_o becomes old and retired. In the latter case, the agent's value function will be that of a recently aged old, $V_r(s'_o)=V_r(a',x',i'_{HI})$, which we define 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. $\tilde{w}$ is the wage per efficiency unit already adjusted by the employer's portion of payroll taxes and benefits cost as specified in (9). If the agent's employer does not offer health insurance benefits, it equals $(1-0.5(\tau_{med}+\tau_{ss}))\,w$, that is, 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 6.[7] Equation (7) represents the income

[7] 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 (6), 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.

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 (8) is a government transfer making sure that after receiving income, paying taxes and health care costs, an individual is guaranteed a minimum level $\bar{c}$ of consumption. Also notice that the health insurance premium 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 (10).[8]

Recently aged agent's problem

$$V_r(s_o) = \max_{c,a'} \{u_o(c) + \beta(1-\rho_d) E[V_o(s_o')]\}$$

subject to

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

ss is the Social Security benefit payment.

Existing old's problem

$$V_o(s_o) = \max_{c,a'} \{u_o(c) + \beta(1-\rho_d) E[V_o(s_o')]\}$$

subject to

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

[8] Theoretically, 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 one at a lower cost, also taking into account the tax break which can be applied only when they choose to purchase an employer-based contract. In our calibrated 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, even for the agents with the best health condition, who could buy a contract in the market at the lowest price. Hence we present the premium $\tilde{p} = p_y(1-\psi)$, when $i_E = 1$ and $i'_{HI} = 1$.

2.8 Health insurance company

The health insurance company is competitive, that is, it charges premia p and $\{p_m(x)\}_{x\in\mathbb{X}_y}$ that precisely cover all expenditures on the insured.

2.9 Stationary competitive equilibrium

We define a stationary competitive equilibrium of the economy. 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 have state vectors $s_{yo} = (a, x, i_{HI})$ and $s_o = (a, x)$, depending on whether they are recently retired or existing old. Let $a \in \mathbb{A} = \mathbb{R}_+$, $z \in \mathbb{Z}$, $x \in \mathbb{X}_j$, $i_{HI}, i_E \in \mathbb{I} = \{0, 1\}$ and $j \in \mathbb{J} = \{y, r, o\}$ 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 $\mathbb{S}_y = \mathbb{A} \times \mathbb{Z} \times \mathbb{X}_y \times \mathbb{I}^2$ and $\mathbb{S}_r, \mathbb{S}_o = \mathbb{A} \times \mathbb{X}_o \times \mathbb{I}$. Let $s \in \mathbb{S}$ denote a general state vector of an agent: $s \in \{y\} \times \mathbb{S}_y$ if young, $s \in \{r\} \times \mathbb{S}_r$ if recently retired and $s \in \{o\} \times \mathbb{S}_o$ if old. The equilibrium is given by

- interest rates r, wage rate w and adjusted wage w_E,
- allocation functions $\{c, a', i'_{HI}\}$ and for young $\{c, a'\}$ for type r, o agents
- government tax system given by income tax function $T(I)$ consumption tax τ_c, Medicare system $\{p_{med}, q_{med}\}$ and Social Insurance program,
- accidental bequests transfer T_B,
- the private health insurance contracts given as pairs of premium and coverage ratios $\{p, q\}$, $\{p_m, q\}$.
- 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 people over the state space $\mathbb{S}$ given by $\mu(s)$,

such that

1. Given the interest rates, the wage, the government tax system, Medicare and the Social Insurance program, and the private health insurance contract, the allocations solve the above described maximization problem for 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 adjusted for the 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 (3).

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

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

5. The health insurance company is competitive:

$$\begin{aligned}(1+r)p &= \frac{\int \sum_{x'} \pi_y(x'|x) x' q(x') i'_{HI}(s) \mu(s|j=y) ds}{\int i_E i'_{HI}(s) \mu(s|j=y) ds} \\ (1+r) p_m(\bar{x}) &= \frac{\int \sum_{x'} \pi_y(x'|\bar{x}) x' q(x') i'_{HI}(s) \mu(s|x=\bar{x}; j=y) ds}{\int (1-i_E) i'_{HI}(s) \mu(s|x=\bar{x}; j=y) ds} \quad \forall \bar{x}\end{aligned}$$

6. Government's general 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-financed.

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

8. Medicare program is self-financed.

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

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. An aggregate resource constraint:

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

where

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

11. 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 specify the parameters used in the simulations. Table 1 summarizes the values and description of the parameters.

3.1 Demographics

A model period corresponds to one year. We define the two generations as follows. Young agents are between the ages of 20 and 64, while old agents are 65 and over. The probability of becoming old ρ_o is set at 1/45 to make sure that agents stay young for an average of 45 years. The death probability ρ_d is calibrated so that the old agents above age 65 constitute 20% of the population, based on data from the panel data set below. This is a slight deviation from the 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 $\frac{\rho_o \rho_d}{\rho_o + \rho_d}$ of young agents enter the economy to replace the deceased old agents.

3.2 Endowment, health insurance and health expenditures

3.2.1 Data Source

For endowment, health expenditure shocks and health insurance, we use income and health data from 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 six two-year panels 1996/1997 up to 2001/2002 with the usual data on demographics, income and most importantly data on health expenditures and insurance, though we drop the first panel because one crucial variable that we need in determining the joint endowment and insurance offer process is missing. We can then calibrate the processes for income and health expenditures and insurance from the same source.

We include all heads of households (both male and female) with non-negative income defined as the sum of labor, business and sales income, unlike many existing studies in the vast 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 comprehensive database like MEPS. In terms of sample units, we choose individuals rather than households to better capture the process for individual health expenditures. Treating health expenditures of a family unit would require adjusting them for different family sizes to fit in our model and will inevitably bias the estimates of persistence. We choose heads instead of all individuals since many non-head individuals are covered by their spouses' health insurance. We include both male and female heads in order to have a larger number of samples, and more importantly, not to drop samples with zero or low assets.

Our model 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 and restricting samples to males does not provide us with a good approximation. In addition, most of the studies are focused on samples with strictly positive income, often with income above some threshold level and such treatment does not fit in our model, either.

Since for young agents we estimate a joint process of income and the group insurance offer status we restrict our attention to those young agents that can be uniquely identified as either being offered or not being offered insurance. Agents that are offered insurance can be easily identified in MEPS by the corresponding dummy variable. Notice that in the data by definition only those agents that are employed can have an insurance offer status. Since we want to generate an income process for both employed and unemployed agents, we consider agents not offered insurance being those that according to MEPS are employed and not offered insurance plus those not currently employed who will have an "inapplicable" offer status.[9] For consistency purposes we also restrict our attention to the same set of agents when we calibrate the health expenditure process for young agents.

3.2.2 Endowment

We calibrate the endowment process jointly with the stochastic probability of being offered employer-based health insurance, for the reasons we discussed in the model section. For the income process, we avoid the detour of first estimating an AR(1) process and then discretizing it with the methods put forth by Tauchen (1986). Instead we specify the income distribution

[9] This implies that we disregard about 10% of the people in the MEPS, namely those that are employed but have unknown/inapplicable insurance offer status and those with unknown employment status. This restriction will not change the shape of the Markov processes in any systematic way. For example comparing the transition probabilities between income groups (unconditional on insurance offer status) between the full and the restricted sample does not generate substantial differences.

over the 5 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 $\pi_{Z,E}(z, i_E | z', i'_E)$ 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.

The transition probabilities averaged over the five panels are

$$\Pi_{Z,E} = \left[\begin{array}{ccccc|ccccc}
0.158 & 0.237 & 0.117 & 0.130 & 0.096 & 0.149 & 0.102 & 0.011 & 0.000 & 0.000 \\
0.059 & 0.479 & 0.209 & 0.073 & 0.042 & 0.041 & 0.066 & 0.020 & 0.008 & 0.002 \\
0.022 & 0.176 & 0.496 & 0.179 & 0.070 & 0.009 & 0.018 & 0.019 & 0.007 & 0.005 \\
0.011 & 0.058 & 0.187 & 0.540 & 0.176 & 0.005 & 0.005 & 0.004 & 0.009 & 0.005 \\
0.012 & 0.026 & 0.057 & 0.169 & 0.710 & 0.005 & 0.004 & 0.003 & 0.003 & 0.010 \\
\hline
0.007 & 0.013 & 0.005 & 0.003 & 0.001 & 0.811 & 0.107 & 0.028 & 0.017 & 0.008 \\
0.014 & 0.055 & 0.041 & 0.017 & 0.006 & 0.178 & 0.466 & 0.141 & 0.051 & 0.031 \\
0.003 & 0.019 & 0.055 & 0.042 & 0.013 & 0.095 & 0.254 & 0.328 & 0.123 & 0.067 \\
0.001 & 0.012 & 0.039 & 0.043 & 0.017 & 0.052 & 0.132 & 0.195 & 0.332 & 0.178 \\
0.000 & 0.001 & 0.007 & 0.019 & 0.048 & 0.065 & 0.118 & 0.132 & 0.180 & 0.428
\end{array}\right]$$

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, for the probability of moving to income bin 2 without insurance next period, conditional upon being in income bin 3 with insurance this today is 1.8%, given by the entry $(3, 7)$.

Finally, in order to get the grids for z, we compute the average income in each of the five bins in 2001 dollars and normalize so that the average income is one:[10]

$$\mathbb{Z} = \{0.042, 0.493, 0.856, 1.295, 2.533\}$$

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 near zero (only 4.5% of average income) for a sizeable measure of the population.

3.2.3 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 MEPS data. Again we use five states. For both young and old we specify the bins of size $(0.40, 0.40, 0.15, 0.04, 0.01)$. For young agents we

[10] Average income per person in 2001 was $33,205.

get the following transition probabilities

$$\Pi_{x_y} = \begin{bmatrix} 0.667 & 0.268 & 0.052 & 0.011 & 0.002 \\ 0.268 & 0.541 & 0.154 & 0.030 & 0.007 \\ 0.143 & 0.414 & 0.343 & 0.087 & 0.014 \\ 0.095 & 0.320 & 0.335 & 0.191 & 0.059 \\ 0.058 & 0.163 & 0.292 & 0.253 & 0.235 \end{bmatrix}$$

with

$$\mathbb{X}_y = \{0.0050, 0.0463, 0.1827, 0.4857, 1.6075\}$$

which are the mean expenditures in the five bins in the first year of the last panel, that is, in the year 2001. The expenditures are normalized in terms of their ratios to the average income in 2001. This parametrization generates average expenditures of 8.37% of mean labor income in the young generation or $2552 in year 2001 dollars.

Notice that the big advantage of our procedure is that we can specify the bins ourselves. Average expenditures in the first bin are just 0.5% of average income which implies that there is very little action in the bottom 40 percent of the expenditure distribution. In contrast, expenditures vary wildly at the top. For example the top 1% have average expenditures of more than 1.5 times the average income (almost $50,000 in 2001). The next 4% have average expenditures of slightly less than 50% of average income ($14,700 in 2001) while the following 15% spend less than 20% of average income ($5,500 in 2001).

Likewise, using the strategy for the old generation we compute

$$\Pi_{x_o} = \begin{bmatrix} 0.668 & 0.251 & 0.065 & 0.014 & 0.002 \\ 0.265 & 0.547 & 0.148 & 0.033 & 0.007 \\ 0.147 & 0.436 & 0.324 & 0.071 & 0.021 \\ 0.075 & 0.312 & 0.336 & 0.205 & 0.072 \\ 0.141 & 0.299 & 0.266 & 0.188 & 0.106 \end{bmatrix}$$

and

$$\mathbb{X}_o = \{0.0270, 0.1330, 0.4505, 1.0920, 2.9227\}$$

which generates unconditional expectation of x_o of 20.64% of mean income or $6,297 in year 2001 dollars.

3.3 Health Insurance

The coverage ratios are calibrated using the same five MEPS panels as before. We average over the five panels and determine the share of expenditures covered by private insurance (conditional on holding insurance) in each of young generation's five expenditure bins:

$$\begin{aligned} q(x_1) &= 0.590 \\ q(x_2) &= 0.649 \\ q(x_3) &= 0.720 \\ q(x_4) &= 0.847 \\ q(x_5) &= 0.880 \end{aligned}$$

There is a proportional operational cost ϕ incurred by insurance companies, which is passed through to the insurance premiums. We assume this cost is a waste ('thrown away into the ocean') and does not contribute to anything. The parameter ϕ is calibrated so that the model achieves the overall take-up ratio of 80% as in the data (MEPS).

The group premium p is determined in equilibrium to ensure zero profits for the insurance company in the group insurance market. We know that the average annual premium of an employer-based health insurance was \$2,051 in 1997[11] or about 7% of annual average labor income. Model simulations yields a premium of 6.97% of average annual labor income.

A firm offering employer-based health insurance pays a fraction ψ of the premium. According to the Medical Expenditure Panel Survey (MEPS), the average percent of total premium paid by employee is 15.6% in 1997.[12] Other studies estimate similar figures and we set it to 15%.[13]

With regards to private health insurance, we assume that the insurance company sets $p_m(x)$ equal to its expected expenditures in the present value plus the operational cost, that is,

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

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.

bin	premium $p_m(x)$
1	0.0271
2	0.0663
3	0.1266
4	0.2425
5	0.5427

One could interpret this as the agents who apply for private health insurance revealing their past medical history and the insurance company charging a premium that ensures zero expected profits for each medical expenditure bin.

[11] Source: MEPS Methodology Report 14, "Estimation of Expenditures and Enrollments for Employer Sponsored Heath Insurance, by John Paul Sommers.

[12] Source: "Estimation of Expenditures and Enrollments for Employer Sponsored Health Insurance," by John Paul Sommers, MEPS Methodology Report 14

[13] 15.1% by National Employer Health Insurance Survey in 1993 and 16% by Employer Health Benefits Survey in 1999.

3.4 Preferences

To determine the health parameters (h_y, h_o) we use data from Domeij and Johannesson (2004) on average health measures for different age groups and then compute the mean health over the two age groups in our model. Normalizing health of the young to one we then find that $h_o = 0.7738$. 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 $\sigma = 2$.

3.5 Technology

Total factor productivity A is normalized so that marginal product of labor equals one in the benchmark. As is standard in the literature the capital share is $\alpha = 0.36$. For the depreciation rate we pick $\delta = 0.06$ following Stokey and Rebelo (1995).

3.6 Government

3.6.1 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 the study by Mendoza, Razin and Tesar (1994).[14]

The income tax function consists of two parts, a progressive income tax and proportional tax on income. The progressive part mimics the actual income tax in the real world following the functional form of Gouveia and Strauss (1994), while the proportional part stands in for all other taxes, that is, non-income and non-consumption taxes that - for simplicity - we lump together into one single tax τ_y levied on income. In summary, we choose the functional form:

$$T(y) = a_0 \left\{ y - \left(y^{-a_1} + a_2 \right)^{-1/a_1} \right\} + \tau_y y. \tag{11}$$

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 Gouveia and Strauss tax function we use their estimates

$$\begin{aligned} a_0 &= 0.258 \\ a_1 &= 0.768 \end{aligned}$$

and choose the scaling parameter a_2 such that the share of government expenditures raised by the progressive part of the tax function $a_0 \left\{ y - \left(y^{-a_1} + a_2 \right)^{-1/a_1} \right\}$ equals 0.6472. This matches the

[14] 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.

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.

3.6.2 Social Insurance program

The threshold level $\bar{c}$ of minimum consumption 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.

3.6.3 Social Security system

We set the replacement ratio ρ at 45% based on the study by Whitehouse (2003). In equilibrium, we have

$$ss \int \mu(s|j=o)ds = \rho \int \tilde{w}z\mu(s|j=y)ds \int \mu(s|j=o)ds = \tau_{ss} \int \tilde{w}z\mu(s|j=y)ds,$$

where the Social Security benefit ss is the replacement ratio times the average wage. Therefore, we have the relationship $\tau_{ss} = \rho\times$ (% of old) / (% of young) yielding a tax rate $\tau_{ss} = 10.57\%$, which is close to the current Social Security tax rate of 12.4%.

3.6.4 Medicare

Just as in the case of private insurance we calculate the coverage ratio of Medicare in the five expenditure bins $x_o \in \mathbb{X}_o$.

bin	$q_{med}(x)$
1	0.299
2	0.381
3	0.605
4	0.713
5	0.639

The Medicare premium 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. In 2003 the Medicare tax rate was 2.9% and its expenditures were about 2.3% of GDP. The model generates expenditures and revenues equal to 2.03% of labor income. This figure is slightly lower than in reality for two reasons. First, in our model Medicare is reserved exclusively for the old generation while the actual Medicare system pays certain expenditures even for young agents. Second, payroll taxes apply to all of labor income while in reality there is a threshold level of currently \$87,900 after which the marginal payroll tax is zero.

4 Numerical results

4.1 Benchmark model

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

The health insurance take-up ratio, that is the share of insured agents, conditional on being offered group insurance is nearly 100% both in the data and our model, and it is 97.3% and 99.5% respectively. The coverage among agents without an access to the group insurance is much lower, 49.3% in the data and 56.3% in the model. Table 2 displays the take-up ratios over health expenditures. Expenditures are expressed in terms of the average labor income. TUR_{all} indicates the overall take-up ratio, TUR_G is the take-up ratio conditional on being offered the group insurance, and TUR_{noG} is the take-up ratio conditional on having no access to the group insurance.

In the model, the TUR_G for the lowest expenditure bin is slightly off the data - 99.4% as opposed to 95.2% in the data. One possible reason is associated with our assumption that all the employers pay 85% of the premium at the firm level, which is based on the average subsidy ratio in the data. In practice, however, some firms cover 100% of the premium and others are less generous. With a small chance of a high health spending in the immediate future, the healthiest agents may choose not be insured if the employer subsidy is sufficiently low.

For the TUR_{noG}, we match the data fairly well except for the ratio for x_1, the healthiest people. There are some factors that could explain the disparity. First, we make a simplifying assumption that there is no information problem as to the health status and an insurance company can charge a break-even price for each x. However, in reality, the health status may not be perfectly observed and the premium can be higher than the lowest price for x_1 that we use in the model. Second, there may be some optimism in reality when you're so young and healthy that you don't evaluate the risk of health properly. This is something that we can't capture in the model and may contribute to a lower take-up ratio.

Table 3 displays the take-up ratios for the five income bins that correspond to the ones in the (Z, E) Markov process. Both in the data and model, take-up ratios increase with income, except for a slight decrease in the highest income bin with no group insurance in the model. The take-up ratios among the agents with a group insurance offer are high, reaching the perfect coverage in the model except for the group with the lowest income. When agents have no access to the group insurance and have a very low or nearly zero income, the take-up ratio drops significantly. 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 more likely to be eligible for the Social Insurance. In case the agents face a high expenditure shock and can only purchase a private health insurance at a high premium, they may choose to remain uninsured and hope to receive the Social Insurance.

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 labor income changes. We fix the Medicare premium p_{med} (in terms of its ratio to output) at the benchmark level and adjust the tax rate τ_{med} to maintain the balance. For the Social Security system, we keep the replacement ratio fixed and adjust the retirement benefit ss to account for the changes in the average labor income.

In each case we compute steady state outcomes. To compare welfare across experiments, we employ an ex-ante criterion. Ex-ante social welfare or Rawlsian welfare of a new-born is defined as

$$SWF_R = \sum_{z,E,x_y} V_y(s|a = 0, x = x_1, i_{HI} = 0) \cdot \bar{p}_{z,E}$$

It is the average of value function for new born agents. $\bar{p}_{z,E}$ is the stationary distribution of z and E. In order to compare social welfare in the experiment and benchmark economies, we compute the consumption equivalent variation, that is the proportional change in consumption in all dates and states of the benchmark economy that makes agents indifferent between the benchmark and the experiment.

4.2.1 Abolishing tax deductibility of group premium costs / fixing regressiveness

In the first set of experiments, we let the government abolish the current deductibility of premium for the purpose of income tax. Income tax is collected on the entire portion of the premium. The taxable income is given as

$$y = \tilde{w}z + r(a + T_B) + i_E i'_{HI} \psi p.$$

Note that not only is the employee portion $i_E i'_{HI} (1 - \psi) p$ no longer tax-deductible, but also the portion paid by the employer is subject to taxation and considered as part of taxable income. This policy will eliminate the regressiveness of the system and restore the vertical inequality created by the progressiveness of the income tax function. For the payroll tax, we consider different scenarios. The five experiments we discuss below differ in the way the government provides subsidy for the purchase of group or private insurance.

Experiment results are summarized in Table 4. Commonly to other experiment results, 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 last two rows $Group$ and $Private$ show the break-down of TUR_G, i.e. the fraction of agents who bought a group insurance ($Group$) or a private insurance ($Private$) conditional on being offered a group insurance. The bottom section displays the aggregate variables including the proportional tax rate τ_y on income that balances the government budget and consumption equivalent variation CEV.

The first experiment (Experiment 1-A) invokes a rather radical change - the government abolishes the entire deductibility of group insurance premium for both income and payroll tax purposes, and does nothing else. The policy leads to a partial collapse of the group insurance market. Those with the lowest health expenditure shock will opt out of the group insurance market and choose to be insured in the private market, if any. It triggers the deterioration of health quality in the group insurance market and the group insurance premium p_{HI} goes up to \$2,974, a huge jump of \$900 from the benchmark. The overall coverage ratio falls by as much as 8%. Although the proportional tax rate τ_y on income is lower than in the benchmark, it is far from enough to compensate for the welfare loss. The low take-up ratio implies more agents are exposed to the health expenditures shock and more fluctuation of disposable income. While increased income uncertainty would induce more precautionary savings in general, it is not the case here. The reason is because the agents who drop out of the insurance market are the healthiest faced with minimal spending on the health care and less likely to be urged to increase savings significantly.

In the next three experiments, the government attempts to correct for regressiveness of the current system and distribute the tax-deductibility more evenly. More precisely, the government abolishes the premium deductibility for the income tax purposes as in Experiment 1-A, and in exchange it gives back a lump-sum subsidy for the purchase of an insurance.

In Experiment 1-B, we assume that the subsidy is given to the purchase of a group insurance at the average income tax rate in the benchmark. The idea is that the government returns the increased revenues due to the abolishment of deductions in the form of lump-sum subsidy, though of course the increase in the revenue and the cost of subsidy will not match exactly because of changes in the insurance demand and other general equilibrium effects. As shown in Table 4, everyone offered a group insurance purchases one under this policy. Compared to the benchmark, this policy is more beneficial if the agent with a group insurance offer belongs to lower income bins, since the deduction was based on their lower tax brackets (or none if unemployed without any income) under the benchmark and the subsidy based on the average tax rate in 1-B is higher than the benefit from the deduction. Everyone who was in the lowest income bin as shown in Table 4 (TUR_G for z_1) now decides to sign up and the perfect TUR is achieved in the group insurance market. The required proportional tax rate τ_y on income is slightly lower than in the benchmark, since the government can collect more tax revenues from the non-linear progressive part of the income tax function. That is, the premium is no longer deductible and added back to the income tax base, which pushes up the marginal tax rate given the progressiveness of the tax system. The decrease in τ_y also contributes to the small rise in TUR_{noG} due to the increased after-tax income and assets. The overall take-up ratio is about a percentage point higher and the ex-ante welfare is marginally above the benchmark level.

In Experiments 1-C and 1-D, the government aims to achieve horizontal equality as well by extending a subsidy to the private insurance market. If an agent has no access to the group insurance, a subsidy of \$1,000 is provided for the purchase of the private insurance. The subsidy is capped by the actual cost of insurance. In Experiment 1-D, the subsidy will phase out if the agent's income exceeds \$30,000. In both experiments, the group insurance is treated as in Experiment 1-B, i.e. there is no income tax deductibility but the government will provide the subsidy for the group insurance at the average income tax rate. As shown in Table 4, the take-up ratio of the private insurance significantly increases in both cases. While the income tax rate τ_y will be higher than in the benchmark or in the previous two experiments due to the increased cost of subsidy, this alone does not dominate the net effect on welfare and the equivalent variations exhibit an increase. Also note that in both experiments the fraction of people covered by the Social Insurance program is about 0.3% lower than in the benchmark (not displayed in the Table), which helps reduce the government expenditures to be financed by the income taxation.

The comparison of the results in Experiments 1-C and 1-D poses a question of costs and efficiency in targeting beneficiaries. By restricting the eligibility to the lower income households in 1-D, the required tax increase from the benchmark is 0.35% as opposed to 0.66% in 1-C. The policy increases the overall TUR by 12.4% and 13.7%, relatively small difference compared to the larger difference in terms of fiscal costs. It becomes more costly to provide an incentive to be insured as the agents' incomes are higher, since the rich households with more assets are better insured by their accumulated savings. Widening the target is easier to implement, but it is equally important to consider efficiency. In fact, we achieve a slightly larger welfare gain by the policy with the income cutoff than by the unconditional subsidy policy.

4.2.2 Extending tax deductibility or subsidy to the non-group insurance market

In the next policy experiments, the government keeps the current deductibility for the group insurance untouched and aims to correct for the horizontal equity by providing a subsidy to the private insurance purchase.

Results are summarized in Table 5. In Experiment 2-A, we extend the same tax advantage for the group insurance to the agents without an access to the group insurance. Agents who purchase a contract in the private market can deduct the premium cost from the income and payroll tax bases. As shown in Table 5, the policy would increase the private insurance coverage by as much as 18% and the overall coverage by 8%. While the government will face an increased cost of providing deductions, the required hike in the tax rate is not so large; τ_y is 4.849% as opposed to 4.546% in the benchmark. One reason is the lower coverage ratio for the Social Insurance. Being more insured against medical expenditures shocks, there are less people who face a catastrophic health expenditure shock that would make them be eligible for the Social Insurance coverage. The fraction of the total population covered by the Social Insurance is lower at 7.51% compared to 7.67% in the benchmark.

In Experiments 2-B and 2-C, the government offers a subsidy of $1,000 for the purchase of a private insurance contract, if the person is not offered a group insurance. In Experiment 2-C, the provision of subsidy is subject to the income threshold of $30,000, above which the subsidy phases out. Similarly to the Experiments 1-C and 1-D of providing a subsidy, there is a large effect on the private insurance coverage. The comparison *between* Experiments 2-B and 2-C will be similar to that between 1-C and 1-D, i.e. the tradeoff between the coverage and efficiency or the cost of providing incentives.

At the bottom of Table 5, we display the TURs among those not offered a group insurance across health expenditure shocks x and income shocks z. In Experiment 2-B, compared to 2-A, there is a much larger increase of the take-up ratios among lower-income households. Providing a subsidy is more effective on them than tax deduction since they do not pay a high tax, or not at all if unemployed. The policy 2-C also works effectively to raise the coverage among the poor, while the coverage among the rich increases only marginally and much less than in 2-B. As shown in the TURs over the expenditure shocks x, both subsidy 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.

When comparing Experiments 2-B and 1-C (or 2-C and 1-D), the difference is whether to keep the current regressive structure of the group insurance tax benefit, or to correct it by making the subsidy independent of the individual marginal tax rates. In the former case (2-B and 2-C), the fiscal cost is higher and τ_y's are 5.336% and 5.017% as opposed to 5.209% and 4.895% in 1-C and 1-D. Also, the overall coverage and welfare are higher when we restore the vertical equity.

Increased risk-sharing will reduce the precautionary saving motives and the aggregate capital and output will be lower than in their benchmark levels. In addition, the increased government involvement will raise the expenditures to be financed by taxation and the proportional income tax rate τ_y will be higher at 5.336% and 5.017% in Experiments 2-B and 2-C, compared to 4.546% in the benchmark. However, the gains from a higher coverage dominates the negative effects and the overall welfare level is higher under both experiments.

5 Conclusion

We set up a model of endogenous health insurance decision in a general equilibrium model rich enough to generate insurance demand closely resembling that observed in the data. We then examine the effects of several tax reforms. The experiments indicate that the tax subsidy on health insurance is desirable though not in the current form. Employer provided group insurance has the feature that everyone can purchase a contract at the same premium price irrespective of any individual characteristics - most importantly it is independent of current health status. However, relatively healthy young agents want to opt out of this contract and either self-insure or find a cheaper insurance contract in the private market. A subsidy on group insurance can therefore encourage even healthy agents to sign up and alleviate the adverse selection problem that plagues the insurance contract. One experiment confirms this intuition by showing that the 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 altogether reduces welfare. We also find that there is room for improving welfare by restructuring the current subsidy system. Extending the subsidy to the private insurance market to restore horizontal equity is effective in raising the insurance coverage and enhancing welfare. An even larger welfare gain is achieved if the government also correct for vertical inequality by eliminating regressiveness of the subsidy system in the group insurance market.

Our work highlights the importance of studying health policy in a general equilibrium framework. Equilibrium prices will necessarily be affected by changes in policy. For example altering the tax treatment of health insurance premia changes the composition of those agents signing 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 the fiscal consequences of a reform - providing subsidy will affect the taxes that must be raised on other sources. The changes in insurance demand can affect the other government sponsored programs such as Medicaid.

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Table 1: Parameters of the model

Parameter	Description	Values
Preferences		
β	discount factor	0.9496
σ	relative risk aversion	2.0
$\{h_y, h_o\}$	health measures	{1.0000,0.7738}
Technology and production		
α	capital share	0.36
δ	depreciation rate of capital	0.06
Government		
$\{a_0, a_1, a_2\}$	income tax parameters (progressive part)	{0.258,0.768,0.739}
τ_y	income tax parameter (proportional part)	4.538%
$\bar{c}$	Social Insurance threshold assets level	12.500% of average income
τ_{ss}	Social Security tax rate	10.569%
	Social Security replacement ratio	45%
$q_{med}(x)$	Medicare coverage ratio	{0.299,0.381,0.605,0.713,0.639}
τ_{med}	Medicare tax rate	2.031%
p_{med}	Medicare premium	2.11% of per capita output
Demographics		
ρ_o	retirement probability	2.22%
ρ_d	death probability after retirement	10.85%
Endowment and health		
$\mathbb{Z}$	labor productivity shocks (Z)	{0.045,0.455,0.804,1.241,2.439}
$\Pi_{Z,E}$	– transition probabilities of Z and E	see text
$\mathbb{X}_y$	health expenditures shocks (young)	{0.005,0.045,0.176,0.467,1.522}
Π_{x_y}	– transition probabilities	see text
$\mathbb{X}_o$	health expenditures shocks (old)	{0.026,0.129,0.437,1.059,2.835}
Π_{x_o}	– transition probabilities	see text
Private health insurance		
$q(x)$	coverage ratio	{0.592,0.646,0.719,0.845,0.891}
p	insurance premium	6.755% of average income
ψ	premium covered by a firm (%)	85.0%

Table 2: Take-up ratios by health expenditures: model vs data

225mmHealth expenditures	x1 0.0050	x2 0.0462	x3 0.1827	x4 0.4857	x5 1.6074
TUR_{all}					
data	0.7382	0.8057	0.7995	0.7909	0.7652
model	0.8092	0.8057	0.7995	0.7909	0.7652
TUR_G $(i_e = 1)$					
data	0.9515	0.9844	0.9881	0.9910	0.9624
model	0.9941	0.9957	0.9971	0.9978	0.9983
TUR_{noG} $(i_e = 0)$					
data	0.3915	0.5796	0.5825	0.4984	0.4894
model	0.5731	0.5631	0.5472	0.5267	0.4676

Table 3: Take-up ratios by income: model vs data

225mmIncome	z1 0.0416	z2 0.4934	z3 0.8559	z4 1.2948	z5 2.5328
TUR_{all}					
data	0.4785	0.7211	0.8871	0.9556	0.9677
model	0.3958	0.7856	0.9448	0.9867	0.9825
TUR_G $(i_e = 1)$					
data	0.8732	0.9275	0.9754	0.9929	0.9942
model	0.8581	1.0000	1.0000	1.0000	1.0000
TUR_{noG} $(i_e = 0)$					
data	0.4161	0.4402	0.5836	0.7455	0.7622
model	0.3538	0.5883	0.8117	0.9349	0.8996

Table 4: Experiment 1: abolishing deductibility of group insurance premium / fixing regressiveness

	Benchmark	1-A	1-B	1-C	1-D
p	\$2,061	\$2,974	\$2,057	\$2,055	\$2,055
TUR_{all}	80.53%	72.73%	81.35%	94.21%	92.93%
TUR_{noG}	56.26%	56.45%	57.54%	86.81%	83.89%
TUR_G	99.53%	85.48%	100.00%	100.00%	100.00%
$Group$	99.53%	57.25%	100.00%	100.00%	100.00%
$Private$	0.00%	28.23%	0.00%	0.00%	0.00%
Agg. output	1.0000	0.9936	0.9995	0.9937	0.9936
Agg. capital	1.0000	0.9825	0.9985	0.9827	0.9824
Interest rate	6.040%	6.177%	6.051%	6.175%	6.177%
Wage rate	1.0000	0.9936	0.9995	0.9937	0.9936
τ_y	4.546%	4.313%	4.437%	5.209%	4.895%
CEV	-	-1.800%	0.056%	0.260%	0.275%
Wealth Gini	0.5570	0.5597	0.5574	0.5515	0.5530

Aggregate output and capital and wage rate are normalized in terms of their benchmark levels.
1-A: abolish group insurance deductibility from income and payroll tax bases
1-B: abolish group insurance deductibility from income tax base and provide credit for group insurance at the average income tax rate
1-C: 1-B plus provide credit of \$1,000 if no access to group insurance
1-D: 1-B plus provide credit of \$1,000 if no access to group insurance, subject to annual income < \$30,000

Table 5: Experiment 2: extending tax deductibility or subsidy to the non-group insurance market

	Benchmark	2-A	2-B	2-C
p	\$2,061	\$2,060	\$2,058	\$2,058
TUR_{all}	80.53%	88.69%	94.05%	92.65%
TUR_{noG}	56.26%	74.83%	86.81%	83.83%
TUR_G	99.53%	99.54%	99.72%	99.55%
Group	99.53%	99.54%	99.72%	83.83%
Private	0.00%	0.00%	0.00%	0.00%
Agg. output	1.0000	0.9987	0.9942	0.9940
Agg. capital	1.0000	0.9963	0.9840	0.9833
Interest rate	6.040%	6.068%	6.165%	6.170%
Wage rate	1.0000	0.9987	0.9942	0.9940
τ_y	4.546%	4.849%	5.336%	5.017%
CEV	-	0.144%	0.204%	0.208%
Wealth Gini	0.5570	0.5532	0.5515	0.5543

TUR_{noG} by z				
z_1 0.0416	35.38%	51.23%	74.25%	73.77%
z_2 0.4934	58.83%	89.66%	95.41%	90.02%
z_3 0.8559	81.17%	99.30%	99.23%	94.35%
z_4 1.2948	93.49%	99.86%	99.42%	97.24%
z_5 2.5328	89.96%	99.93%	99.81%	91.72%
TUR_{noG} by x				
x_1 0.0050	57.31%	76.14%	93.32%	90.32%
x_2 0.0462	56.31%	74.69%	84.33%	81.29%
x_3 0.1827	54.72%	72.98%	79.21%	76.32%
x_4 0.4857	52.67%	71.14%	75.92%	73.32%
x_5 1.6074	46.76%	67.05%	69.24%	67.12%

Aggregate output and capital and wage rate are normalized in terms of their benchmark levels.
All: keep the current tax deduction system for the group insurance
2-A: extend the same deduction for the purchase of private insurance
2-B: 2-A plus provide credit of \$1,000 if no access to group insurance
2-C: 2-A plus provide credit of \$1,000 if no access to group insurance, subject to annual income $<$ \$30,000