Macroeconomic Consequences of Alternative Reforms to the Health Insurance System in the U.S.

Zhigang Feng

IBF, University of Zurich

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Abstract

In this paper I employ a dynamic general equilibrium model to study macroeconomic effects and welfare implications of alternative reforms to the U.S. health insurance system. In particular, I focus on to what extent a health care reform can reduce inefficiency originating from market imperfections in the health insurance market. I consider a stochastic OLG framework with heterogeneous agents facing uncertain health shocks. Individuals make optimal decisions on labor supply, health insurance, and medical services. As the amount of optimal medical consumption and hours worked are endogenous, this environment captures general equilibrium effects. The model is calibrated to the U.S. data. Numerical simulations indicate that appropriate modification to the current health insurance system can expand coverage and improve welfare through reducing adverse selection, enhancing health status and curtailing tax distortion on labor supply.

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1 Introduction

It is well known that the American health care system has many virtues. There are also large well-documented inefficiencies inside this system, mainly unnecessarily high costs related to the delivery of medical care and market imperfections in the health insurance market. According to the OECD data, 16.3% of the U.S. economy was devoted to health care in 2007, compared with 8.9% in the average OECD country and 11.6% in second-placed Switzerland. Despite of the high share of health care expenditure in the U.S, its life expectancy is lower than that of any other high-income country and infant mortality rate is substantially above that of other developed countries. Market failures in the provision of health insurance create incentives for socially inefficient levels of coverage. In 2007, 17% of the non-elderly in the U.S. was uninsured according to Kaiser’s (2008) data. The lack of insurance has serious negative consequences including lack of access to needed care, declining health, and the possibility of crushing financial burdens. Uninsured adults are far more likely to postpone accessing health care or to forgo it altogether and are less able to afford prescription drugs or follow through with recommended treatments. Institute of Medicine (2003) reported that the uninsured have a more rapid decrease in general health and a higher risk of dying prematurely than the insured. According to their estimation, the cost for diminished health and shorter life span due to lack of insurance was between $65 and $130 billion in 2003. There are also financial externalities imposed by the uninsured on the third party through uncompensated care, whose costs were estimated to be $57.4 billion in 2008 [Hadley et al. (2008)].

These facts have stirred up various proposals for changing the U.S. health care system and covering the uninsured. A large number of empirical studies have explored the impacts of health care reforms on individual’s behaviors such as crowding-out by public insurance [e.g. see Culter and Gruber (1996), Lo Sasso and Buchmueller (2004), Gruber and Simon (2008)], medical usage [Cheng and Chiang (1997)], and health status [Lurie et al. (1984), Currie and Gruber (1996), Hanratty (1996), Decker and Remler (2005)]. However, there is a paucity of economic models that address the macroeconomic and welfare implications of reforming the U.S. health care system. Several recent studies employed microsimulation models to evaluate health care reform proposals [see Gruber (2008), Meara et al. (2008)]. They are rich in institutional detail and utilize a tremendous amount of micro data, but they are subject to usual limitations, namely the incapability of providing insights into the general
equilibrium effects of such reforms and their welfare implications.

The health care system consists of delivery of medical care and provision of health insurance. At a fundamental level, most existing reform proposals are designed to slow health cost growth and expand insurance coverage. The health care delivery system is large and complex and the cost growth cannot be contained quickly and easily. It also relies on our understanding about the factors that drive the health care cost growth which is less studied compared with adverse selection and other market imperfections in health insurance market. Therefore this paper focuses on the aspects of reforms that aim at reducing the market imperfections in the provision of health insurance.

A reform of the health insurance system could potentially affect macroeconomic variables by distorting the labor market through changes in tax rates, reducing the number of uninsured, and raising the aggregate health expenditure. Reforming the health insurance system will affect the household’s demand for health insurance. Some individuals may shift from existing private insurance coverage to either a newly subsidized form of private coverage or to public coverage. This in turn alters the pool of agents insured, which affects insurance premiums. Similarly, different insurance decisions result in changing health status and labor productivity, which then will affect wages and hours worked. A change in the labor income tax may be required to fund the reform which will influence individual’s labor supply decisions. A reform will also change agents’ saving behaviors (and thus the aggregate capital stock and factor prices) because health insurance may reduce precautionary saving motives. At the same time, better health implies longer life expectancy and thus a higher saving incentive. These complicated tradeoffs can only be fully captured in a general equilibrium framework.

The aim of this study is to analyze the macroeconomic impacts and welfare implications of alternative reforms to the health insurance system in the U.S. I depart from the existing literature by adding endogenous health expenditure and labor-leisure choice in order to capture some important welfare tradeoffs. I consider the following reform proposals: (i) the expansion of Medicare to the entire population; (ii) the expansion of Medicaid; (iii) an individual mandate; (iv) the removal of the subsidy to purchase the employer-sponsored insurance. These reforms are building blocks for major proposals for reform. I calibrate my model to the U.S. data. Then, I conduct several policy experiments to shed light on the costs and benefits of changing the health insurance system. My numerical experiments suggest
that general equilibrium effects are substantial, and the impact of various reforms on the social welfare can be quite sizable.

My research is closely related to a number of studies. My model is built upon the classic works of Bewley (1986), Imrohoroglu (1992), Huggett (1993) and Aiyagari (1994), which provide a useful framework to study the economy with heterogeneous agents and incomplete market. Several papers introduce exogenous health expenditure shocks into Bewley-type models. For example, Palumbo (1999) and De Nardi et al. (2006) incorporate heterogeneity in medical expenses in order to understand the pattern of savings among the elderly. Jeske and Kitao (2009) study the welfare costs of a tax policy change associated with health insurance. Different from these papers, here I consider household’s optimal consumption of medical service following the health capital literature in the spirit of Grossman (1972). Recent examples include Hall and Jones (2007), Suen (2006) that explain the rapid growth in health expenditure. Jung and Tran (2008) analyze the effect of the Health Saving Accounts on the health expenditure and individual’s insurance decision. All these studies use an inelastic labor supply. In this paper, agents make the labor-leisure choice and the government adjusts tax rates to fund the reforms, which creates distortions in the labor supply. This study is thus related to the literature on taxation and labor supply (Prescott (2004), Rogerson (2007)).

I build on this literature in two ways. First and foremost, the focus of my paper is to develop a macroeconomic framework to quantify effects of alternative health care reforms. The existing literature generally focuses on one specific health related policy. I explicitly model public health insurance so that my model can evaluate a broad set of health care reforms. Second, my model takes into account general equilibrium effects regarding the demand and supply of labor and the consumption of medical services. As I show later, introducing labor-leisure choice provides new insights for understanding the welfare implication of health care reforms. Numerical simulations suggest that effect of reforms on labor supply is non-negligible.

The paper is organized as follows. Section 2 introduces the OLG model and section 3 is devoted to the calibration of the utility and production functions with emphasis on some parameters related to health. Section 4 details some reform proposals and presents all numerical results. The last section concludes.
2 The benchmark model

2.1 Demographics

This economy has overlapping generations of agents who live a maximum of three periods as young, middle-aged, and old. Let \( g \in \{1,2,3\} \) denote the age. In the first period, the measure of newly born agents is normalized to 1. Individuals alive in period \( t \) survive to the next period with a certain probability. For old people this probability is always 0. For young and middle-aged people, the survival probability is given by \( \rho(h_g) \), which depends on the health status \( h_g \) at the end of age \( g \) as described below. The population of young individuals grows at a constant rate \( n \), implying that the population of young in period \( t \) is \((1 + n)^t\). I denote the relative size of age \( g \) to the population as \( \mu_g \), which is determined in the equilibrium.

2.2 Agent types

All individuals enter the economy with the same level of health \( \bar{h}_0 \), an idiosyncratic endowment \( e_0 \), and an idiosyncratic health risk types \( i_h \). Health risk type determines the probability of drawing a certain health shock \( \varepsilon_t \in \Omega_\varepsilon = \{\varepsilon^1, \ldots, \varepsilon^{N_\varepsilon}\} \). The probability distribution of the shock is assumed to be age-type-dependent. Specifically, the probability of drawing \( \varepsilon \in \Omega_\varepsilon \) by type \( i_h \) agent at age \( g \) is denoted by \( p_{g,i_h}(\varepsilon) \), with \( \sum_{\varepsilon \in \Omega_\varepsilon} p_{g,i_h}(\varepsilon) = 1 \) for all \((g, i_h)\). A typical history of shocks up to time \( t \) is denoted by \( \sigma_t \equiv \{\varepsilon_0, \ldots, \varepsilon_t\} \), with \( \sigma_{t+1} = \{\sigma_t, \varepsilon_{t+1}\} \).

Agents are endowed with a fixed amount of time per period that can be allocated to leisure or labor. Agents participate in the labor market during the first two periods and receive a wage income \( \tilde{w}\varepsilon^chl \). Here \( \zeta \) measures the effect of health on labor productivity.\(^1\) Health is an important form of human capital. It can enhance workers’ productivity by increasing their physical capacities, such as strength and endurance, as well as their mental capacities. I postulate a positive relationship between health and labor productivity.

During their work stage agents receive income in the form of wages and profit \( \Pi_t \) from the firm. They can also save \( a_g \) units of the consumption good using a storage technology with gross rate of return \( R_{t+1} = 1 + r \). Retired agents have income through previous saving and profit, and consume all of their income at their last period of life.

\(^1\)See Bloom and Canning (2005). They model the human capital of the worker by \( v = e^{\phi_s s + \phi_h h} \), where \( s \) represents years of schooling and \( h \) represents health. Here I normalize the effect of schooling.
The type of an agent is a triple \((g, i_h, x)\), where \(g \in \{1, 2, 3\}\) is age; \(i_h \in \{\text{healthy, unhealthy}\}\) is health risk type; and \(x \in \mathbb{R}_+\) is their disposable resources at the beginning of each period which is defined as follows:

\[
x = \begin{cases} 
e_0, & \text{if } g = 1 \\ (1 + r)a_1, & \text{if } g = 2 \\ (1 + r)a_2 & \text{if } g = 3 \
\end{cases}
\]

(1)

2.3 Preferences

Preferences over stochastic sequences of consumption, leisure and health are given by

\[
U = \mathbb{E}_t \left\{ \sum_{g=1}^3 \beta^{g-1} \Pi \rho(h_{g-1}) \cdot u(c_g, L_g, h_g) \right\} 
\]

(2)

where \(\beta\) denotes the discount factor, \(\rho\) survival probability, \(c\) consumption, \(L\) leisure and \(h\) health status. \(\mathbb{E}_t\) denotes the conditional expectation with the information available when the agent is born.

2.4 The evolution of health

I use the idea of health capital introduced by Grossman (1972). In the model, each agent chooses an optimal amount of medical consumption \(m\) to offset the negative effect of health shock \(\varepsilon\) on health and builds up health capital \(h\). The accumulation process of health is given by:

\[
h' = (1 - \delta_h)h + \frac{\varepsilon}{\exp[A_m m^\zeta]}. 
\]

(3)

where \(\delta_h\) represents the natural deprecation rate of health and \(A_m\) measures the medical technology.\(^2\) I assume that technological progress in the production of medical service \(A_m\) is exogenously given. The price of medical care \(p_m\) is exogenously given so that each unit of consumption good can be transformed into \(1/p_m\) units of medical care.

In previous literature that explores the macroeconomic effects of health related policies [e.g. Jeske and Kitao (2009)], the health expenditure is treated as an exogenous random

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\(^2\)In Suen (2006), Jung and Tran (2008) the health accumulation technology is characterized by \(h' = (1 - \delta_h)h + f(m) + \varepsilon\), which implies that the agent can be perpetual young and healthy as long as she/he invests enough into health. Here I modify their assumption and bound the current health by the remained health after natural aging.
shock. Individuals must pay the full amount for necessary health care after the health expenditure shock is revealed, independent of their income level and current health stock. In the current study, medical expenditures are endogenously chosen by agents to build up their health stocks. Since health expenditure is an endogenous choice, richer agents will spend more on health care to build up better health stock than the poor who has the same health status and faces the same health shocks. This can be explained by the fact that rich individuals have higher levels of consumption and lower marginal utility from consumption goods, therefore they will substitute some health for consumption goods.\(^3\)

Conditional on being alive at the current age with end of period health stock \(h\), agent will survive to the next period with probability \(\rho(h)\). Death is certain when health falls below zero (\(\rho(h) = 0\) if \(h \leq 0\)). I assume that \(\rho'(h) > 0\). Deceased agents leave their savings \(a\) as an accidental bequest that is collected by the government as revenues.

### 2.5 Medical expenses and health insurance

Non-elderly can choose one out of three possible insurance states labeled as \(in = \{1, 2, 3\}\). To purchase private health insurance is \(in = 1\), \(in = 2\) denotes that the agent has Medicaid, and \(in = 3\) indicates that the agent is uninsured. The out of pocket health expenditure will be \((1 - \tilde{q}(p_m m, 1))p_m m\) if the agent chooses to buy insurance and \((1 - \tilde{q}(p_m m, 2))p_m m\) when he/she is covered by the government program. It will cost the entire expenditure \(p_m m\) if the agent does not have insurance(\(\tilde{q}(p_m m, 3) = 0\)). Here \(\tilde{q}(p_m m, in)\) is function that represents the coinsurance rate and varies with the health insurance state \(in\) as we discuss in the following subsection. Agents take coinsurance rate as given and it is calibrated from the data. Retired agents are insured under Medicare.

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\(^3\)Wobus, Diana Z. and Gary Olin (2005) found that the average health expenditure decreases with income level. This can be reconciled by the following fact. The low income has lower health insurance coverage rate. For people age under 65, the uninsurance rate among person in families with income less than 200% of poverty line is 24.5%, while the number is only 8.7% among person in middle and high income families. The price of medical services is much higher for uninsured due to the cost shifting (see Anderson (2007)), which implies the medical services utilized by low income families can be less than those used by the rich counterpart.
2.5.1 Private health insurance

To simplify the analysis, I only consider the Employer-Sponsored Health Insurance (EHI).\(^4\) Even when an employer offers health insurance, not all workers get coverage. Some choose not to enroll, perhaps because they are young or very healthy and feel that health insurance is not a pressing need, and others’ incomes are so low that they cannot afford insurance. These tradeoffs will be presented in the benchmark simulation.

Once an agent chooses to purchase EHI a constant premium \(\pi_E\) must be paid to the insurance company, among which a fraction \(\kappa \in [0, 1]\) is paid at the firm level. The premium is not dependent on prior health history or any individual states. This accounts for the practice that group health insurance does not price-discriminate the insured by such individual characteristics. To maintain the zero profit condition, the health insurance company set the premium \(\pi_E\) such that it is enough to cover the insurance company’s share \(q_E(p_m m)\) of the total medical expenditure incurred by the costumers.

2.5.2 Public health insurance

The government provides two type of health insurances, Medicaid and Medicare, to the population.

**Medicaid**  Medicaid is a joint federal-state program that provides health insurance coverage to four main categories of non-elderly low-income individuals (typically below 134 percent of the federal poverty level, which is $13,100 for individual in 2007): children, their parents, pregnant women, and individuals with disabilities. Individuals who do not fall into one of these groups may be ineligible for Medicaid regardless of their income. Although Medicaid covers 45 percent of those below the poverty level, the categorical requirement leaves 35 percent of low-income individuals without insurance coverage. I assume that young and middle-aged individuals are eligible to receive Medicaid if their current income is lower than the poverty line \(Y_{ma}\). There is also an exogenous probability \(\chi\) of getting a Medicaid offer. This captures the categorical requirement of Medicaid. The program will cover the fraction \(q_{ma}(p_m m)\) of the total medical expenditure. Medicaid is a part of government spending.

\(^4\)In the data, more than 90% non-elderly who have private insurance purchase through their employers.
Medicare I assume that all retirees are enrolled in the Medicare program. Each retiree pays a fixed premium $\pi_{mr}$ for Medicare and the program will cover the fraction $q_{mr}(p_{mm})$ of the total medical expenditures. Medicare is funded by government revenues.

2.6 Aggregate production function

The consumption goods are produced by a neoclassical production function. The aggregate production function takes a nested Cobb-Douglas specification in the following form.

$$Y = F(E) = AE^\alpha$$  \hspace{2cm} (4)

$$E_t = \sum_{g=\{1,2\}} \mu_g(t) \int [e^{\xi_h}I_g(s_g, \varepsilon_g)] f_g ds_g$$  \hspace{2cm} (5)

where $A_t$ is a total factor productivity, and $E_t$ is an aggregate efficiency labor input, which depends on individual worker’s health status. The firm adjusts the wage to maximize the profit, and subtracts the cost of providing health insurance $c_E$. The adjusted wage is given by $w - c_E$, where $w = F_E(E)$ and $c_E = \kappa \pi_E$.

To contain the computational cost, the capital does not enter the production function. This assumption brings positive profit $\Pi_t$ in the equilibrium, which will be distributed back to households as a lump-sum payment. Consequently, part of the agent’s income is inelastic, which will underestimate the distortions of income taxation.

2.7 The representative agent’s problem

A representative agent of generation $g = \{1, 2\}$ enters the economy with characteristics $s_g = (i_h, x, h_{g-1}, i_{ma})$, where $i_h$ is the risk type of the agent, $x$ is the net wealth, $h_{g-1}$ is the health status at the beginning of the period, and $i_{ma}$ is the indicator function that signals the availability of the Medicaid benefit in the current period. Since all old agents are automatically enrolled in the Medicare program and leave the labor market, their characteristics simply are $s_3 = (i_h, x, h_2)$. The distribution of households over their state space is given by $f_g(s_g, \sigma_t)$, which is endogenously determined in the equilibrium and evolves over time.

Agents observe $s_g$ at the beginning of the period. They take prices and taxes as given and make the insurance decision $i_{mg}(s_g)$ and choose a set of state-contingent decision rules, which can be denoted by $\{c_g(s_g, \varepsilon_g), a_g(s_g, \varepsilon_g), m_g(s_g, \varepsilon_g), L_g(s_g, \varepsilon_g)\}$, to solve the following
problem.

\[
\max_{t} E_t \left\{ \sum_{g=1}^3 \beta^{g-1} \Pi \rho(h_{g-1}) \cdot u \left[ c_g(s_g, \varepsilon_g), L_g(s_g, \varepsilon_g), h_g(s_g, \varepsilon_g) \right] \mid \sigma_t \right\} \quad (6)
\]

subject to the budget constraint and a no-borrowing constraint

\[
(1 + \tau_c) c_1(s_1, \varepsilon_1) + \left[ 1 - \tilde{q}(p_m m_1, in_1) \right] \cdot p_m m_1(s_1, \varepsilon_1) + \tilde{\pi}(in_1) + a_1(s_1, \varepsilon_1) \\
\leq e_0 + \Pi_t + (1 - 0.5 \tau_{mr}) \tilde{w}_t - Tax \\
a_1(s_1, \varepsilon_1) \geq 0 \quad (7)
\]

when young;

\[
(1 + \tau_c) c_2(s_2, \varepsilon_2) + \left[ 1 - \tilde{q}(p_m m_2, in_2) \right] \cdot p_m m_2(s_2, \varepsilon_2) + \tilde{\pi}(in_2) + a_2(s_2, \varepsilon_2) \\
\leq R_{t+1} a_1 + \Pi_{t+1} + (1 - 0.5 \tau_{mr}) \tilde{w}_{t+1} - Tax \\
a_2(s_2, \varepsilon_2) \geq 0 \quad (9)
\]

when middle-aged; and

\[
(1 + \tau_c) c_3(s_3, \varepsilon_3) + \left[ 1 - q_{mr}(p_m m_3) \right] \cdot p_m m_3(s_3, \varepsilon_3) + \pi_{mr} \\
\leq R_{t+2} a_2 + \Pi_{t+2} - Tax \quad (11)
\]
when old, where

\[
\tilde{w}_t = \begin{cases} 
  w_t e^{ch_l} - 1_{\{in = 1\}}c_E, & \text{if } in = 1 \\
  w_t e^{ch_l}, & \text{if } in = 2, 3
\end{cases} \tag{12}
\]

\[
\Pi_t = \frac{(1 - \alpha)Y_t}{\sum_{g=\{1,2,3\}} \mu_g \int f_g ds_g} \tag{13}
\]

\[
p_m = \begin{cases} 
  p^i_m, & \text{if } in_g = 1, 2 \\
  p^a_m, & \text{if } in_g = 3
\end{cases} \tag{14}
\]

\[
\tilde{\pi}(in_g) = \begin{cases} 
  (1 - \kappa)\pi_E, & \text{if } in_g = 1 \\
  \pi_{ma}, & \text{if } in_g = 2 \\
  0, & \text{if } in_g = 3
\end{cases} \tag{15}
\]

\[
\tilde{q}(p_{m,m}, in_g) = \begin{cases} 
  q_E(p_{m,m}), & \text{if } in_g = 1 \\
  q_{ma}(p_{m,m}), & \text{if } in_g = 2 \\
  0, & \text{if } in_g = 3
\end{cases} \tag{16}
\]

\[
\text{Tax} = T(y) + 0.5\tau_{mr} \left[ \tilde{w}_t - 1_{\{in = 1\}}\tilde{\pi} \right] \tag{17}
\]

\[
y_g = \begin{cases} 
  \tilde{w}_t + \Pi(\sigma_t) - 1_{\{in_g = 1\}}\tilde{\pi}, & \text{if } g = 1 \\
  ra_1 + \tilde{w}_{t+1} + \Pi(\sigma_{t+1}) - 1_{\{in_g = 1\}}\tilde{\pi}, & \text{if } g = 2 \\
  ra_2 + \Pi(\sigma_{t+2}), & \text{if } g = 3
\end{cases} \tag{18}
\]

\[
h_g = (1 - \delta_h)h_{g-1} + \frac{\varepsilon_g}{\exp[A_m m_g(s_g, \varepsilon_g)]} \tag{19}
\]

The timeline for the generation who was born in period \( t \) is shown in Figure 1. Each agent born at \( t \) is endowed with \( e_0 \). Consumptions, out-of-pocket medical expenditures, payments of insurance premium and savings are financed by assets, profits from the ownership of the firm, labor incomes if applicable, net of incomes and payroll taxes.

Equation (12) presents the individual’s after-Medicare-tax adjusted wage income. The firm needs to share the Medicare tax \( \tau_{mr} \) with the agent. Hence, in equilibrium a fraction \( 0.5\tau_{mr} \) of tax is subtracted from the wage. Profit \( \Pi_t \) will be uniformly distributed to the household as payment as displayed in equation (13). The price of medical service \( p_m \), marginal cost of the insurance premium \( \tilde{\pi} \) and coinsurance rate \( \tilde{q} \) depend on the insurance states \( in_g \) as given in equations (14), (15) and (16). Individual is responsible to Medicare tax and a progressive income tax \( T(\cdot) \) which is imposed on the labor income paid to a worker plus accrued interest on savings and profit from the firm as in (17). Equation (18) represents the income tax base, which depends on the agent’s age. Health plays three important roles
in the economy: good health promote labor productivity at a factor of $e^{\zeta h}$, agents derive utility from health, and survive to the next period with probability $\rho(h_g)$. Equation (19) explains the evolution of health.

2.8 The government

I impose a government balanced budget constraint period by period. The government has three different types of outlays: general public consumption, Medicaid and Medicare expenses. The government collects revenues from various sources: income taxation according to a progressive tax function $T(\cdot)$, consumption taxation at rate $\tau_c$, Medicare taxation at rate $\tau_{mr}$, Medicare premium $\pi_{mr}$, Medicaid premium $\pi_{ma}$, and accidental bequests $B$ collected from deceased agents.

$$G_t + \sum_{g=\{1,2\}} \mu_g(t) \int [q_{ma}(p_m m_g) p_m m_g - \pi_{ma}] \cdot 1\{in=3\} f_g ds_g + \mu_3(t) \int [q_{mr}(p_m m_3) p_m m_3 - \pi_{mr}] f_3 ds_3$$

$$= R_t B_t + \sum_{g=\{1,2\}} \mu_g(t) \int \tau_{mr} [\tilde{w}_t - 0.5 \cdot 1\{in=1\} \tilde{\pi}] f_g ds_g + \sum_{g=\{1,2,3\}} \mu_g(t) \int [\tau_c c_g + T(y_g)] f_g ds_g$$

(20)

where $y_g$ is the taxable income for age $g$ agent.

Figure 1: Timeline for the generation born in period $t$
2.9 Health insurance company

The health insurance company is competitive. Hence, in equilibrium the premium $\pi_E$ is charged such that expected expenditures on the insured are precisely covered.

$$\pi_E = \frac{\sum_{g=\{1,2\}} \mu_g(t) \int [q_E(p_m m_g)p_m m_g \cdot 1_{\{in=1\}}] f_g ds_g}{\sum_{g=\{1,2\}} \mu_g(t) \int 1_{\{in=1\}} f_g ds_g} \tag{21}$$

Notice the coverage ratio function $q_E(\cdot)$ is taken as exogenously given.

2.10 Stationary competitive equilibrium

Let $i_h \in I^2 = \{healthy, unhealthy\}, x \in \mathbb{R}_+, h_g \in \mathbb{R}_+, i_{ma} \in I^2 = \{0, 1\}, \varepsilon_g \in \mathbb{R}_-$. The state space for age $g = \{1, 2\}$ year old agents is $S_g = I^2 \times \mathbb{R}_+ \times \mathbb{R}_+ \times I^2 \times \mathbb{R}_-$, and the state space for the old is $S_3 = I^2 \times \mathbb{R}_+ \times \mathbb{R}_+ \times \mathbb{R}_-$.

Definition 1 A stationary competitive equilibrium is i) fiscal variables $\{G, \tau_c, T(\cdot), \tau_{mr}\}$; ii) price for medical services $p_m$; iii) health insurance choices $\{in(s_g)\}_{g=1,2}$, a set of state-contingent decision rules $\{c_g(s_g, \varepsilon_g), a_g(s_g, \varepsilon_g), m_g(s_g, \varepsilon_g), L_g(s_g, \varepsilon_g)\}_{g=1,2,3}$ for the agents; iv) a state-contingent sequence of labor demand $E$; v) insurance premium $\pi_E$; vi) distributions of agents $f_g(s_g)$ over the state space $S$ such that

1. $\{in(s_g), c_g(s_g, \varepsilon_g), a_g(s_g, \varepsilon_g), m_g(s_g, \varepsilon_g), L_g(s_g, \varepsilon_g)\}_{g=1,2,3}$ solve the consumers problem (6) taking prices and fiscal variables as given;

2. given the distribution $f_g^*$ of households, the insurance companies choose $\pi_E$ such that the budget constraint of insurance companies (21) holds;

3. the government sets $\tau_{mr}$, and $T(\cdot)$ such that (20) holds;

4. given price $w$, the labor market clears

$$E = \sum_{g=\{1,2\}} \mu_g \int e^{c_h g}_g l_g(s_g, \varepsilon_g) f_g ds_g \tag{22}$$

5. the accidental bequests matches the remaining assets.

$$B = \sum_{g=\{1,2\}} \mu_g \int a_g(s_g, \varepsilon_g) \cdot (1 - \rho(h_g, \varepsilon_g)) f_g ds_g \tag{23}$$
6. the aggregate resource constraint holds
\[ G + \sum_{g=\{1,2,3\}} \mu_g \int \left[ c_g(s_g, \varepsilon_g) + p_m m_g(s_g, \varepsilon_g) \right] f_g ds_g + \sum_{g=\{1,2\}} \mu_g \int a_g(s_g, \varepsilon_g) f_g ds_g \]
\[ = \mu_1 \int \varepsilon_0 f_1 ds_1 + \sum_{g=\{1,2\}} \mu_g \int R_t \cdot a_g(s_g, \varepsilon_g) f_g ds_g + Y + B \]
(24)

7. there is a consistency between beliefs and the actual prices.

8. the relative size of age \( g \) to the population \( \mu_g \) is recursively determined by
\[ \mu_g = \frac{\int \rho(h_g-1, \varepsilon_g-1) f_{g-1} ds_{g-1}}{1 + n} \mu_{g-1} \]
(25)

9. the law of motion for the distribution of agents over the state space \( S \) satisfies
\[ f_{g}^{t+1} = \int \rho(h_g-1, \varepsilon_g-1) f_{g-1}^{t} ds_{g-1} \]
(26)

3 Calibration

In this section I outline the calibration of the model. Table 1 summarizes the values and describes the parameters.

Most parameters can be independently estimated. However, there are 16 parameters that cannot be determined independently of each other as I discuss below. These include parameters of preference over health \( (\gamma_{3,g}, \eta) \), the health production function \( (A_m, \zeta) \), the survival probability function \( (a_\rho, b_\rho) \), the magnitude of the negative health shock \( (\varepsilon^1, \varepsilon^2) \), the probability distribution of the shock \( p_{g,ih} \) and the price of medical service \( p_m \). Hence, I use a minimization procedure to determine these parameter values. More specifically, I pick parameter values to match key moments in the stationary distribution of the benchmark model with the real-world statistics listed in Table 5. Formally, let \( \psi \) denotes the vector of parameters, and \( \Gamma \) be the vector of selected real-world moments. Given \( \psi \), a prediction \( \hat{\Gamma}(\psi) \) on \( \Gamma \) can be computed in the stationary distribution of the benchmark. The minimization procedure can be defined as the following problem:
\[ \min_{\psi} \left\| \hat{\Gamma}(\psi) - \Gamma \right\| \]
(27)
3.1 Data sources

The data used for estimating the process of health insurance decision and health production come from the Household Component of 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 from 1996/1997 up to 2003/2004 and includes data on demographics, income and most importantly health status and health insurance.

3.2 Demographics

In the model, one period is defined as 20 years. Agents enter the economy at the age of 25 ($g = 1$) and survive up to the maximum age of 85 ($g = 3$). In line with Suen (2006), I assume that the survival probability function $\rho(\cdot)$ takes the form of the cumulative Weibull distribution function:

$$\rho(h) = 1 - \exp(-a_p h^{b_p})$$

with $a_p > 0$ and $b_p > 0$. The endogenous survival probability rules out the case that agents survive to the next period with negative health stock.

I consider a yearly population growth of 1.25%. Together with the survival probability $\rho(h)$, the ratio of retired people to active population (the dependency ratio) is equal to 30% (24.3% according to the 2000 Population Census for the U.S.). The initial level of health when agent enter the economy, $\bar{h}_0$, is assumed to be constant and is normalized to be 100.

3.3 Preferences and technology

Agents have period utility over consumption, leisure and health:

$$u(c_g, L_g, h_g) = \log c_g + \gamma_{2,g} \log L_g + \gamma_{3,g} \frac{h_g^{1-\eta}}{1-\eta}$$ (29)

The parameter $\gamma_{2,g}$ is age-dependent and I choose parameter values such that the average fraction of the time endowment allocated to market work is 0.33, which implies $\gamma_{2,1} = 1.03$, and $\gamma_{2,2} = 0.68$. Notice old agents retire from the labor market and they spend all time on

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5 Data source: http://www.census.gov/population/estimates/nation/intfile2-1.txt
leisure. For simplicity I set $\gamma_{2,3} = \gamma_{2,1}$. $\gamma_{3,g}$, which is age-dependent as is $\gamma_{2,g}$, measures the importance of health and $\eta = 1.35$ denotes the coefficient of relative risk aversion of health.

The annual subjective discount factor is taken to be 0.97, so $\beta = (0.97)^{20} = 0.5936$. The average annual interest rate in the U.S. is 4%, so $r = (1 + 0.04)^{20} - 1 = 1.19$.

### 3.4 Production of health and health shocks

The health measure $h$ used in this paper is the Physical Component Summary scores formed from the answers to the Short-Form 12 questions. For people aged between 25 and 85, the lowest health level is 4.56 and the highest level is 72.17 in the MEPS data.\footnote{As for how to calculate these summary scores, please refer to Ware et al, How to Score the SF-12(r) Physical and Mental Health Summary Scales, QualityMetric,Inc., Lincoln, RI.} This paper assumes that human beings can live up to 85 years without any accident or illness. I choose $\delta_h$ such that $72.17 \times (1 - \delta_h)^{60} = 4.56$, where $\delta_h$ refers to annual health depreciation rate. I also assume that the depreciation rate increases with age. Therefore I choose depreciation rate of $\{0.4, 0.4, 0.5\}$.

The transition of agent’s health is described by equation (3). Agents can offset the negative effect of a health shock by purchasing medical care. The productivity of medical care is captured by $A_m$, and the price of medical care is $p_m$. Both are exogenously given.

Brown (2006) found that uninsured people in California pay 65% more for common prescription drugs than the federal government does for the same medications. Anderson (2007) found that the uninsured patients pay up to 2.5 times for hospital service than health insurers. I assume that uninsured consumers pay a 60% higher price for medical services than the insured, so that $p_m^u = 1.6 \times p_m^i$. This is similar to Jung and Tran (2008). I assume that the relative price of medical service $\bar{p}_m$ is the weighted average price paid by the insured and the uninsured, i.e. $\bar{p}_m = (1 - \theta)p_m^i + \theta p_m^u$, where $\theta$ is the fraction of uninsured in the population. According to Kaiser (2007), the value of $\theta$ was 17% in 2006. Therefore, I pick $p_m^i = 0.9145\bar{p}_m$, and $p_m^u = 1.4605\bar{p}_m$.

I differentiate agents into two groups, which are high-risk and low-risk, by using the estimation procedure of Bundorf, M. Kate et al (2005). The health shocks take two possible values $\{\varepsilon^1, \varepsilon^2\}$. For the same age cohort high-risk people are different from low-risk people in terms of the probabilities $p_{g,i_h}(\varepsilon)$ of getting a same shock $\varepsilon$. The health shocks $\varepsilon \in \Omega_\varepsilon = \{\varepsilon^1, \varepsilon^2\}$ and the probability distribution of the shock $p_{g,i_h}(\varepsilon)$ are chosen so that the health
insurance take-up rate (percentage of workers buying private insurance per age-type group) and the share of health expenditure in GDP are approximated.

3.5 Health insurance

Private health insurance Data suggests that the coverage rate increases in the health expenditures incurred by the patients. Therefore I assume that the coverage ratio is a function of total health expenditure $p_mm$ and takes the following form similar to Jeske and Kitao (2009).

$$q_E(p_mm) = \beta_0^E + \beta_1^E \log(p_mm) + \beta_2^E [\log(p_mm)]^2$$

First, I estimate the set of parameters $\{\beta_0^E, \beta_1^E, \beta_2^E\}$ using the MEPS data. I sort the health expenditure into quantiles and use five uniform-sized bins for health expenditure data. Then I plug in the health expenditure data to attain the average coverage ratio for each bin.

The coverage ratios of Medicaid and Medicare are estimated by the same procedure. I report the parameter values and coverage ratios for each expenditure grid in table 3 and 4. In table 4, the standard errors in brackets and all coefficient estimates are significant at the 1% level. The insurance premium $\pi_E$ is determined in the equilibrium to ensure zero profits for the insurance company.

Medicaid I use Medicaid as a proxy of public health insurance for the non-elderly population, which includes S-CHIP. I use the MEPS data to calculate the acceptance rate of Medicaid $\chi = 0.7$. The beneficiaries of Medicaid typically do not pay anything for enrolling in the program. I pick $\pi_{ma} = 0$ in the simulation.

Medicaid is funded by general government revenue. The income level characteristic of Medicaid is typically 100% to 133% of the federal poverty line (FPL). I set $Y_{ma} = $13,000 or about 34% of annual per capita GDP in the benchmark.

Medicare I assume that every old agent is enrolled in Medicare. Medicare taxes are levied on all labor income and split between employer and employee contributions. The Medicare premium was $799.20 annually in 2004 or about 2.11% of annual GDP. The Medicare tax rate $\tau_{mr}$ is determined within the model so that the government budget is balanced.

---

3.6 Firms

I choose a standard labor share in production of $\alpha = 0.66$ from NIPA. Without loss of generality, total factor productivity is normalized to $A = 8$ such that the average labor income equals 10 in the benchmark. In line with Bloom and Canning (2005), I assume that individual worker’s health status affects the efficiency of labor input by a factor of $e^{\xi h}$. Therefore, labor income is given by $we^{\xi h}l$, where $w$ is the average wage rate. I estimate the parameter $\xi$ that fits the following equation using the MEPS data.

\[
\log(Labor\,Income) = \xi h + \log(Average\,Wage \times Working\,Hours) + \epsilon \tag{31}
\]

where $h$ is the Physical Component Summary scores that measure the individual’s health status ranging from 0 to 100. I normalize the average labor income observed in the data to be 10.0 and I calculate $\xi = 0.1072$ in the benchmark.

3.7 Government

The value for $G$ is exogenously given and is fixed across all policy experiments. I calibrate it to 18.0% to match the share of government consumption, social security and gross investment excluding transfers, at federal, state and local levels (The Economic Report of the President, 2004). The consumption tax rate is 5.67% as in Mendoza, Razin, and Tesar (1994).

The income tax function follows the functional form studied by Gouveia and Strauss (1994), which is given as

\[
T(y) = b_0 \left(y - (y^{-b_1} + b_2)^{-1/b_1}\right) + \tau_y y \tag{32}
\]

Parameter $b_0$ is the limit of marginal taxes in the progressive part as income goes to infinity, $b_1$ denotes the curvature of marginal taxes and $b_2$ is a scaling parameter. I use the parameters estimated by Gouveia and Struss (1994), which are $\{b_0, b_1, b_2\} = \{0.258, 0.768, 0.716\}$. When they calibrate the tax function, the income has been normalized to the range of $[0, 1]$. In my model, I divide taxable income of every agent by the maximum income observed in the simulated economy to get the normalized income. Then I use this normalized income directly in equation (32) to get the tax rate. The parameter $\tau_y$ in the proportional term of the income tax equals 4.46% in the benchmark.
4 Numerical results

In this section, I will first discuss the features of my benchmark model. Then I conduct counterfactual experiments in which alternative policies are carried out.

4.1 Benchmark model

Table 5 reports the main features of the benchmark simulation. Under the baseline parameterizations the model is able to match the health insurance demand and aggregate health expenditure in the U.S. The fraction of insured agents among all young and middle-aged agents is 82.9%, which is almost the same as 83.0% in the data. Among non-elderly, 10.3% are covered by the Medicaid program (12.9% in the data). The model slightly underestimates total health expenditure as a ratio of GDP, which is about 16.3% according to the Department of Health & Human Services (2006). The model reports 16.1%.

My model does not match the wealth distribution accurately even though I introduce idiosyncratic health shock. This can be explained by the fact that agents do not have bequest motive and the profits generated from production have been uniformly distributed back as a lump sum payment in the model economy. Nevertheless, the accuracy of approximation of the entire wealth distribution won’t impose strong effect on the prediction of health insurance demand, which will be determined by the fraction of the population whose wealth is below certain threshold. As described in the previous paragraph, the health insurance take-up profile and aggregate health expenditure match with the data fairly well. Therefore I leave the current setting as it is.

Next, I examine the model’s predictions on the life-cycle patterns of medical spending and consumption. Panel 1 of Figure 2 displays medical spending over various age groups with the same statistics from the MEPS. Both in the data and model, the average health expenditure is roughly constant between ages 25 and 64 and climbs afterwards. The benchmark model is able to replicate the increasing pattern. However, the size of the health expenditure of non-elderly agents as a ratio of GDP is bigger than the one observed in the data. The main reason is that the agent enters the economy with same amount of health stock in the model. The labor productivity effect of health may overstate the investment in medical service among young agents. This can be resolved by introducing heterogeneity in initial health but with some extra computational cost. In the model, a representative agent age between 25 and 44
spends $4,676 or about 11.9% of per capita GDP (7.5% in the data). Agents between ages 45 and 64 years old on average spend $4,667, or about 11.8% of per capita GDP (11.0% in the data). Agents over 65 spend $12,848, or about 32.7% of per capita GDP (32.6% in the data).

Panel 2 of Figure 2 shows the consumption over various age groups. Fernandez-Villaverde and Krueger (2002) estimated the life-cycle consumption profiles using data from the Consumer Expenditure Survey. They found that non-durable consumption peaked at age 52 and was about 29% higher than at age 25. The current model is able to generate a similar hump-shaped pattern. However, there is a gap between the benchmark prediction and data. This can be attributed to the fact that there is no capital in the model for the sake of simplification. The direct consequence of this strategy is that the demand for saving is inelastic and therefore part of the government income taxation is distortion free as discussed in the section explaining the firm’s problem.

4.2 Policy experiments

I now conduct experiments to determine the effect of reforming the health insurance system. All potential reforms start from the same initial 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. I first compare moments of associated invariant distributions and then discuss the welfare analysis associated with each of the reforms considered.

I am interested in changes in health expenditure as a ratio of GDP, changes in taxes that balances the government budget, aggregate labor supply, aggregate health status, savings rate, the output as well as welfare implications. I treat changes in government revenue as follows: expenditures $G$, consumption tax rate $\tau_c$, and the income tax remaining unchanged from the benchmark. The government adjusts the medicare tax $\tau_{mr}$ to balance the budget.

In each experiment I compute a steady state outcome under the stationary equilibrium. In line with the methodology as explained by Conesa and Krueger (1999), this paper measure the welfare effect of a reform by computing the consumption equivalent variation ($CEV$). I quantify the welfare change of a given policy reform for an individual type $(i_h, x, i_{ma})$ by asking how much (in percent) this individual’s consumption has to be increased in all future periods and contingencies (keeping health expenditure, leisure and health insurance status constant) in the old steady state so that his expected life-time utility equals that under a specific policy reform. I denote it with $CEV(i_h, x, i_{ma})$. For example, a $CEV(i_h, x, i_{ma})$ of $-1.0\%$ indicates that if the given policy reform is put into place, an individual type $(i_h, x, i_{ma})$ will experience a welfare loss which is equivalent to sacrificing $1.0\%$ of her consumption in the initial steady state with leisure, health insurance and health expenditure constant at the initial choices.

In order to isolate the distortion effect of the labor taxation, I also conduct companion experiments in which the government funds the reform through a lump-sum transfer.

4.2.1 Policy experiment A: expansion of Medicare to the entire population

In this experiment the private health insurance and Medicaid program are abolished. The government extends Medicare to the entire population. Since the paper is about the aspects of the reform which aim at reallocating existing resources more efficiently by reducing the market imperfection in the provision of health insurance, I keep the average price level for medical service $\bar{p}_m$ and medical technology $A_m$ the same as the benchmark. It is also important to understand how individuals will respond to the changes in cost-sharing. Therefore, I consider two cases in which the government extends Medicare with different coinsurance rate
to the non-elderly population. It is worth noting that Medicaid has the lowest cost-sharing in terms of coinsurance rate and Medicare has the highest according to MEPS data.

In the experiment A-1, the government extends the Medicare coverage to the entire population which implies that the reform provides an incentive for the non-elderly to be more cautious about their medical spending due to higher cost-sharing. While in the experiment A-2, the non-elderly will be covered by a uniform health insurance program with premium $\pi_{mr}$ and coinsurance rate $q_E(\cdot)$. Specifically, they pay for a premium that equals 2.1% of the per capita GDP which is cheaper than the counterpart in the benchmark.\(^8\) A fraction $q_E(p_m m)$ of their health expenditure will be paid by the government. This reform leaves the majority of the non-elderly, namely those who have insurance coverage through their employers in the benchmark, unchanged in terms of cost-sharing. However, those low-income agents who rely on Medicaid will be responsible for a bigger share of their health expenditure.

The experiment results are summarized in column A-1 and A-2 of Table 4.2.1. The top section displays some statistics of aggregate variables: fraction of insured non-elderly, Medicare tax rate, average effective income tax rate, average hours worked, and the health expenditure as a ratio of GDP. The mortality rate for each age group is also presented as a proxy of health status. The lower section displays the welfare effects of each reform. $\% \ w/ CEV > 0$ indicates the fraction of agents in the benchmark that would experience a welfare gain (positive CEV) if an alternative reform is taken place.

Expansion of Medicare to the entire population achieves a universal coverage as shown in the fraction of insured non-elderly. However, the aggregate health expenditure does not necessarily grow as the number of uninsured drops. In experiment A-1, the share of total spending in health care as a ratio of GDP shrinks to 14.8%, while the share expands by 0.3 percent in A-2. This can be attributed to the difference in changing cost-sharing which affects the agent’s incentive. Higher cost sharing will contain spendings in health care by providing an incentive for the consumer to use the resource more cautiously as in experiment A-1. Consequently, the aggregate level of health status will deteriorate and the mortality rate will rise. While lower cost-sharing in experiment A-2 will encourage the non-elderly to spend more on medical service which results in improved health. A natural question is whether this deterioration/improvement in health can be justified by the cost saving/growth. The answer

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\(^8\)In the benchmark, 72.6% of non-elderly who purchase private insurance pay an actuarially fair premium $\pi_E$, which is about 8.9% of the per capita GDP.
seems positive if we ignore the effect of tax distortion and reduced adverse selection which are the subject of welfare analysis. In experiment A-1, the government will save approximately $150 billion at a cost of higher mortality rate which will be around $136 billion if we assume that the value of statistical life is $6.8 million [c.f. Bellavance et. al (2006)]. Similarly, the value of life saved will amount to $406 billion after experiment A-2 is implemented, while the extra health cost is merely $34.6 billion.

The expansion of public health insurance requires the government to raise tax revenue to cover 17.1% of the non-elderly who would be uninsured in the benchmark. The government also needs to pay for part of the expenditure of the previously insured who pay about 20.0% of the premium before the reform. Meanwhile, the reform also saves some tax revenues through changes in the arrangement in the health care sector. In the benchmark, the government provides Medicaid to the low incomes, which costs 1.2% of total GDP. It also subsidizes the purchase of group insurance and the total subsidy amounts to 0.8% of total GDP. Once the reform is implemented, the government can save these spendings, since both Medicaid and private insurance are abolished. Considering both of them, the government raises the Medicare tax rate to 6.0% in experiment A-1 and 14.7% in A-2 which will discourage labor supply and the average hours worked decrease by 6.8% and 15.7% accordingly. Total output shrinks by 2.2% in A-1 and 5.5% in A-2 as labor supply drops.

Although agents are subject to a higher labor tax after the reform is implemented, the agents will benefit from the policy A-1 with guaranteed access to insurance coverage. The health insurance market is free of adverse selection problems after the reform is implemented. As shown in \( \% w/ CEV > 0 \), 77.6% of agents would experience a welfare gain from this reform and the average welfare effect is in the order of 0.1% in terms of consumption in all states. However, low income agents, especially those covered by Medicaid before the reform, will suffer from this policy because the new insurance program from such a reform is less generous than Medicaid. On average, low-income individuals would experience a welfare loss equivalent to 5.7% of consumption, compared with a welfare gain equivalent to 1.9% of consumption for agents who have incomes above the poverty line. In contrast to A-1, A-2 makes most of the individuals worse off because the after-reform labor tax is so high that the benefit can not compensate for the cost.

Fund the reforms by labor tax
<table>
<thead>
<tr>
<th></th>
<th>Bench.</th>
<th>A-1</th>
<th>A-2</th>
<th>B-1</th>
<th>B-2</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insured non-elderly (in %)</td>
<td>82.9</td>
<td>100.0</td>
<td>100.0</td>
<td>85.0</td>
<td>93.4</td>
<td>100</td>
<td>79.2</td>
</tr>
<tr>
<td>Medicare tax (in %)</td>
<td>2.2</td>
<td>6.0</td>
<td>14.7</td>
<td>5.1</td>
<td>5.7</td>
<td>4.8</td>
<td>1.8</td>
</tr>
<tr>
<td>Ave. income tax (in %)</td>
<td>20.4</td>
<td>20.6</td>
<td>20.1</td>
<td>20.3</td>
<td>20.3</td>
<td>20.2</td>
<td>20.5</td>
</tr>
<tr>
<td>Ave. Working hrs.</td>
<td>32.4</td>
<td>30.2</td>
<td>27.3</td>
<td>31.4</td>
<td>31.1</td>
<td>31.7</td>
<td>32.5</td>
</tr>
<tr>
<td>Health exp. (in % of GDP)</td>
<td>16.1</td>
<td>14.8</td>
<td>16.4</td>
<td>16.6</td>
<td>16.6</td>
<td>16.8</td>
<td>15.9</td>
</tr>
<tr>
<td>$\pi_E$ (in % of per capita GDP)</td>
<td>8.7</td>
<td>2.1</td>
<td>2.1</td>
<td>8.5</td>
<td>8.5</td>
<td>8.3</td>
<td>9.0</td>
</tr>
<tr>
<td>Output</td>
<td>100.0</td>
<td>97.8</td>
<td>94.5</td>
<td>99.5</td>
<td>99.0</td>
<td>99.3</td>
<td>100.1</td>
</tr>
<tr>
<td>Aggregate saving rate (in %)</td>
<td>26.9</td>
<td>27.5</td>
<td>27.9</td>
<td>27.1</td>
<td>27.2</td>
<td>27.0</td>
<td>26.8</td>
</tr>
<tr>
<td>Average consumption</td>
<td>100.0</td>
<td>99.2</td>
<td>94.0</td>
<td>99.1</td>
<td>98.6</td>
<td>98.2</td>
<td>100.5</td>
</tr>
<tr>
<td>Mortality rate (age 25-44)</td>
<td>0.0322</td>
<td>0.0324</td>
<td>0.0322</td>
<td>0.0321</td>
<td>0.0321</td>
<td>0.0321</td>
<td>0.0322</td>
</tr>
<tr>
<td>Mortality rate (age 45-64)</td>
<td>0.1343</td>
<td>0.1343</td>
<td>0.1323</td>
<td>0.1335</td>
<td>0.1328</td>
<td>0.1317</td>
<td>0.1349</td>
</tr>
<tr>
<td>Lifetime CEV after transition all (in %)</td>
<td>−</td>
<td>0.1</td>
<td>−2.6</td>
<td>0.2</td>
<td>−1.1</td>
<td>−1.7</td>
<td>−2.1</td>
</tr>
<tr>
<td>income &gt; $Y_{ma}$ (in %)</td>
<td>−</td>
<td>1.9</td>
<td>−0.03</td>
<td>−1.1</td>
<td>−0.6</td>
<td>−1.1</td>
<td>−2.8</td>
</tr>
<tr>
<td>income ≤ $Y_{ma}$ (in %)</td>
<td>−</td>
<td>−5.7</td>
<td>−10.9</td>
<td>0.8</td>
<td>−1.3</td>
<td>−3.8</td>
<td>−0.1</td>
</tr>
<tr>
<td>% w/ CEV &gt; 0</td>
<td>−</td>
<td>77.6</td>
<td>37.3</td>
<td>7.5</td>
<td>4.3</td>
<td>0.0</td>
<td>16.4</td>
</tr>
</tbody>
</table>

A-1: Medicare expansion 1.
A-2: Medicare expansion 2.
B-1: Public health insurance expansion 1.
B-2: Public health insurance expansion 2.
C: Individual mandate.
D: Abolish private insurance deductibility from income tax base.

4.2.2 Policy experiment B: expansion of public health insurance

Reform B involves expansion of the public health insurance, including Medicaid/S-CHIP [Gruber (2006)]. Approaches that follow this model generally build on existing public programs by raising income limits to include more needy people and do away with all tests of eligibility except income. In experiment B-1, I increase the Medicaid offer rate to $\chi = 1.0$, compared to a probability of 0.7 in the benchmark, i.e. the new Medicaid program covers all the low income but not just eligible low income parents and children as required in the current system. While in experiment B-2, the government keeps the categorical requirement of Medicaid unchanged and increases the maximum income requirement to 200% of the poverty
The spending in Medicaid as a ratio of GDP increases from 1.2% to 2.5% when the government extends Medicaid to include more low-income agents. These newly insured consume more medical services because Medicaid provides them with better insurance coverage. Aggregate health expenditure increases by 0.5% and the Medicare tax rate has been more than doubled to match this spending. Average hours worked decreases by 4.0% even though the labor productivity has been improved due to improved health. Medicaid expansion alone cannot achieve “universal insurance coverage” and this reform will still leave 15.0% of the non-elderly without insurance coverage. Those are agents in better health condition who think insurance is not critical important to them.

When the government increases the maximum income requirement in experiment B-2, some previously insured agents will choose to apply for Medicaid because Medicaid is the best insurance money can buy, even though they will face the risk of being uninsured because of categorical requirements of Medicaid. Overall, the insured as a fraction of non-elderly increases to 93.4%. Similar to the preceding experiment, the aggregate health expenditure increases. While average health outcome is better than after experiment B-1 is taken place due to the higher insurance coverage. Consequently, the aggregate hours worked decreases by 3.1% as Medicare tax jumps to 5.7%.

Compared to the benchmark, policy B-1 is intended to be beneficial for agents with income below the poverty line. These agents are qualified for Medicaid with a certain probability determined by categorical requirements of this program in the benchmark. Now they benefit from this reform with a guaranteed public insurance coverage and pay a cost in terms of a higher labor tax. Given the small size of the program, the benefit is enough to compensate for the loss due to the tax increment. They experience a welfare gain in the order of 0.8% in terms of consumption in all states. For high income agents, their health benefits are intact after the reform since they are not qualify for Medicaid, but they subject to a higher income tax to support the expanded Medicaid program. Their welfare loss is equivalent to 1.1% in terms of consumption in all states.

To increase the maximum income requirement makes more agents worse off. Agents whose income is below the existing maximum income requirement have the same public insurance coverage as in the benchmark. However they are required to pay for a higher tax rate to fund the expanded Medicaid. Therefore, they experience a welfare loss in the order of 1.3%
in consumption equivalence. High income agents benefit from the reform with a chance of being covered by Medicaid depending on their income level. While the cost of higher income tax cannot be offset by this benefit. Consequently, they experience a welfare loss of the order of 0.6% in terms of consumption, which is in a smaller magnitude compared with low income agents who do not benefit from this reform.

4.2.3 Policy experiment C: individual mandate

In this experiment those agents who are uninsured in the benchmark are required to purchase private insurance. Their entry into the insurance market makes the risk pool more inclusive and the price of the group insurance falls to $3,340 from the benchmark price of $3,418. The aggregate health expenditure as a ratio of GDP rises to 16.7% as the insurance coverage increases. The aggregate health status has been improved and the average hours worked decrease by 2.2% as the reform requires a higher Medicare tax \( \tau_{med} \) since the tax deductibility has been extended to the previously uninsured. In terms of welfare, an individual mandate makes everybody worse off. Such a reform imposes a higher tax rate since more individuals will deduct premiums from income taxes. This welfare loss cannot be compensated by the cheaper insurance resulting from a more inclusive risk pool. On average, agents experience welfare loss in the order of 0.6% of consumption in all states. Among low-income agents, only a small fraction holds private insurance since most of them are covered by Medicaid. Consequently they benefit less from the cheaper insurance and they experience a welfare loss at the magnitude of 3.8% in consumption equivalence, compared with a loss in the order of 1.1% for high income agents.

4.2.4 Policy experiment D: abolishing tax deductibility of EHI premiums

To understand the economic effects of endogenizing medical spending and labor-leisure choice, I conduct policy experiment A considered by Jeske and Kitao (2009). Under this experiment, the deductibility of the insurance premium for income tax is removed. The taxable income does not depend on the insurance status and it is given as follows

\[
y_g = \begin{cases} 
\bar{w}t e^{\sigma_1} l_1(s_1, \varepsilon_1) + \Pi(\sigma_1), & \text{if } g = 1 \\
ra_1(s_1, \varepsilon_1) + \bar{w}t e^{\sigma_2} l_2(s_2, \varepsilon_2) + \Pi(\sigma_1), & \text{if } g = 2 \\
ra_2(s_2, \varepsilon_3) + \Pi(\sigma_1) & \text{if } g = 3 
\end{cases}
\] (33)
Experiment results are summarized in column D of Table 4.2.1. Removing the subsidy in D leads to a drop in insurance take-up as found by Jeske and Kitao (2009). Since I don’t differentiate between group insurance and insurance purchased in the private market, the magnitude of drop is much smaller. The fraction of non-elderly who purchase private insurance falls from 72.6% to 68.9%. There are only about 4% of the non-elderly opt out of the private insurance market and choose to be self-insured. Those are healthy agents who face a lower probability of suffering a bad health shock. The exit of these agents out of the insurance market deteriorates the risk pool and the price of the private insurance jumps by 3.5% to $3,536. The aggregate health expenditure as a ratio of GDP falls by 1.2% because taking away the tax deductibility discourages investment in health.

The Medicare tax $\tau_{med}$ on labor income that balances the government budget falls from 2.2% to 1.8%, since the income tax base is expanded by eliminating the deductibility of the EHI premium. Consequently the average hours worked increase by 0.5%. Although the tax rate $\tau_{med}$ is lower than in the benchmark, it is not enough to compensate for the welfare loss due to the lower insurance coverage, increased exposure to health shocks, and deteriorated health. Most agents will face a welfare loss except those low-income individuals who relies on Medicaid will benefit from the policy with their insurance coverage intact.

Compared with the findings in Jeske and Kitao (2009), the welfare implications are qualitatively identical. While my numerical simulations complement theirs by suggesting that output will expand as labor supply increases and medical spending drops as agents are more aware of the cost of insurance. Furthermore, the agents will spend more on consumption goods instead of less as found in their paper.

### 4.3 To fund reforms by a lump-sum transfer

The analysis so far indicates that the change in taxes may play a dominant role in how health care reforms affect the welfare. In order to isolate the effect of tax distortion, I also conducted companion exercises in which the government funds the reform through a lump sum transfer. In the companion experiments, the tax rates are kept intact as in the benchmark. The government returns a lump sum transfer to each individual. The transfer is determined so that the government’s budget is balanced.

Numerical results in Table 4.3 indicate that the labor supply effect of health care reforms
is rather small. The greatest change in hours worked is observed in experiment A-1 in which the hours worked decreases by 2.2%, compared to an average 5.3% change when the reforms are funded through the Medicare tax. Nevertheless, reforms to the health insurance system have quite sizable effects on the welfare. Medicare expansion increases welfare by improving health status and reducing adverse selection in the health insurance market. While expansion of Medicaid and individual mandate decreases welfare by distorting health insurance purchase and health expenditure decision, even thought average health status has been improved after reforms are carried out.

Overall, reforms that can decrease the number of uninsured (as in A-2, B-1, B-2 and C) while don’t alter agents incentives in medical spending will improve the aggregate health status. As the newly insured can invest more in health, the aggregate health spending rises as well. Improved health encourages labor supply as labor productivity is positively correlated with health. As shown in experiment C, average hours worked increases by 0.9%. Among the reforms considered, only experiment D fails to decrease the number of the uninsured. Aggregate health expenditure decreases as fewer people have insurance coverage in experiment D. The average health stock falls as well.

The comparison between policy A-1 and A-2 highlights the importance of cost-sharing in containing the health care growth. Both policies expand the insurance coverage to the entire population. While policy A-1 can actually save more than $150 billion per year if we assume that the delivery of health care maintains at the current state. This cost saving mainly comes from providing the incentive for consumers so that they are more aware of their spending.

Fund the reforms by lump-sum transfer
<table>
<thead>
<tr>
<th></th>
<th>Bench.</th>
<th>A-1</th>
<th>A-2</th>
<th>B-1</th>
<th>B-2</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insured non-elderly (in %)</td>
<td>82.9</td>
<td>100.0</td>
<td>100.0</td>
<td>87.3</td>
<td>93.6</td>
<td>100</td>
<td>80.5</td>
</tr>
<tr>
<td>Medicare tax (in %)</td>
<td>2.2</td>
<td>2.2</td>
<td>2.2</td>
<td>2.2</td>
<td>2.2</td>
<td>2.2</td>
<td>2.2</td>
</tr>
<tr>
<td>Ave. income tax (in %)</td>
<td>20.4</td>
<td>20.8</td>
<td>20.9</td>
<td>20.4</td>
<td>20.5</td>
<td>20.3</td>
<td>20.4</td>
</tr>
<tr>
<td>Ave. Working hrs.</td>
<td>32.4</td>
<td>31.7</td>
<td>32.6</td>
<td>32.5</td>
<td>32.4</td>
<td>32.7</td>
<td>32.3</td>
</tr>
<tr>
<td>Health exp. (in % of GDP)</td>
<td>16.1</td>
<td>14.7</td>
<td>16.1</td>
<td>16.5</td>
<td>16.7</td>
<td>16.7</td>
<td>16.0</td>
</tr>
<tr>
<td>$\pi_E$ (in % of per capita GDP)</td>
<td>8.7</td>
<td>2.1</td>
<td>2.1</td>
<td>8.7</td>
<td>8.5</td>
<td>8.3</td>
<td>9.0</td>
</tr>
<tr>
<td>Output</td>
<td>100.0</td>
<td>99.5</td>
<td>100.7</td>
<td>100.3</td>
<td>100.4</td>
<td>100.4</td>
<td>99.9</td>
</tr>
<tr>
<td>Aggregate saving rate (in %)</td>
<td>26.9</td>
<td>27.4</td>
<td>27.6</td>
<td>26.9</td>
<td>27.1</td>
<td>26.9</td>
<td>26.8</td>
</tr>
<tr>
<td>Average consumption</td>
<td>100.0</td>
<td>100.9</td>
<td>99.3</td>
<td>99.8</td>
<td>100.6</td>
<td>99.2</td>
<td>100.3</td>
</tr>
<tr>
<td>Mortality rate (age 25-44)</td>
<td>0.0322</td>
<td>0.0324</td>
<td>0.0322</td>
<td>0.0320</td>
<td>0.0320</td>
<td>0.0321</td>
<td>0.0322</td>
</tr>
<tr>
<td>Mortality rate (age 45-64)</td>
<td>0.1343</td>
<td>0.1341</td>
<td>0.1318</td>
<td>0.1337</td>
<td>0.1328</td>
<td>0.1316</td>
<td>0.1347</td>
</tr>
<tr>
<td>Lifetime CEV after transition</td>
<td></td>
<td>0.9</td>
<td>-1.1</td>
<td>0.9</td>
<td>0.5</td>
<td>-1.7</td>
<td>-2.2</td>
</tr>
<tr>
<td>all (in %)</td>
<td></td>
<td>-2.5</td>
<td>0.6</td>
<td>0.2</td>
<td>0.6</td>
<td>-1.2</td>
<td>-2.8</td>
</tr>
<tr>
<td>income &gt; $Y_{ma}$ (in %)</td>
<td></td>
<td></td>
<td>-3.9</td>
<td>1.8</td>
<td>0.4</td>
<td>-3.3</td>
<td>-0.3</td>
</tr>
<tr>
<td>income ≤ $Y_{ma}$ (in %)</td>
<td></td>
<td>80.6</td>
<td>71.6</td>
<td>19.4</td>
<td>10.3</td>
<td>0.0</td>
<td>16.4</td>
</tr>
<tr>
<td>% w/ CEV &gt; 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A-1: Medicare expansion 1.
A-2: Medicare expansion 2.
B-1: Public health insurance expansion 1.
B-2: Public health insurance expansion 2.
C: Individual mandate.
D: Abolish private insurance deductibility from income tax base.

5 Concluding remarks

In this paper, I build up a micro-founded dynamic general equilibrium model to study the impact of alternative health care reforms on the aggregate labor supply, health expenditures, savings, welfare, and the fraction of uninsured population. In contrast to some papers in the literature, I consider a model with a labor-leisure choice as well as a health expenditure decision. These latter choices may change the demand for medical services, which in turn affects the individual’s health status and labor productivity. Moreover, financing reform may create distortions on the labor supply by requiring additional tax revenues. The magnitude of the distortion depends on the details of the reform as well as the funding method.

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The following important tradeoffs should be considered when evaluating alternative approaches to reform the U.S. health insurance system: the reduction in the number of uninsured population, labor market distortions, and the cost of raising public funds to cover government programs. These complicated tradeoffs can only be fully captured in a general equilibrium framework, similar to the one employed in my analysis. My results suggest that the Medicare expansion and the individual mandate are good candidates for achieving universal health care, while a removal of the tax subsidy to purchase private insurance would result in a significant reduction in the insurance coverage.

Depending on the details of the reforms and how they are funded, I find that the impact of various reforms on the aggregate labor supply ranges between $-8.4\%$ and $0.9\%$. In some reforms, such as the expansion of Medicare to the entire population and the expansion of Medicaid, cheaper insurance means a better health risk pool, lower premiums and better health, which in turn increases labor productivity and hours worked. However, some reforms require higher taxes which result in lower working hours, as for instance in the expansion of Medicare and the individual mandate.

I also find that an increase in insurance coverage does not always improve social welfare. Here, social welfare is measured in terms of the consumption equivalent variation (CEV), and the impact of various reforms varies between $-2.6\%$ and $0.9\%$. While the expansion of health insurance coverage does not necessarily imply higher medical cost. It is worth to mention that the government can maintain the welfare and contain the cost while expand the insurance coverage by adjusting the cost-sharing as in experiment A-1.

Since the purpose of the paper is to focus on the effects of reforming the health insurance system, I have chosen not to alter the health production sector along the transition. However, as the demand for medical services may change after a reform is implemented, the supply side may be affected as well. An interesting extension of the current paper would be to ask how productivity in the medical sector and the price of medical services are determined and how they will be affected by these health insurance reforms.

**References**


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6 Appendix

6.1 Computation algorithm to stationary equilibrium

Given the parameter values as shown in the text, I compute the stationary equilibrium as follows:

Step 1. Discretize the state space $S = (i_h, x, h, i_{ma}, \varepsilon)$.

Step 2. Start with an arbitrary pair of the steady state values of aggregate labor supply $E$, tax rate $\tau_{mr}$, bequest $B$, and private health insurance premium $\pi_E$. Define $\Theta = \{E, \tau_{mr}, B, \pi_E\}$. Compute the value of wage $w$.

Step 3. Agents solve their optimization problem.

Step 4. Simulate the economy:

4.1. Set $t = 0$, there are $N_{ppl}$ agents live in the economy, who are randomly assigned the values of $(i_h, x, h_{g-1}, i_{ma}, \varepsilon_g)$ if young or middle-aged, and $(i_h, x, h_{g-1}, \varepsilon_g)$ if retired.

4.2. Given shocks agents choose whether to insure, how much to save, and how much to spend;

4.3. New period starts, $t = t + 1, g = g + 1$, the government collects the assets left behind by the accidentally deceased.

4.4. A sequence of time series is generated by repeating step 4.2 & 4.3;

4.5. Store the distribution of $\{\{i_h, x, h_{g-1}, i_{ma}, \varepsilon_g, \text{ing}_g\}\}_{g=1}^3$ with $\{\Psi_g\}_{g=1}^3$;

4.6. Stop the process if the economy enters the stationary distribution.

Step 5. Compute the insurance premium $\pi_{E,new}$, aggregate labor supply $E_{new}^{new}$, bequest $B_{new}$, and tax rate $\tau_{mr,new}$ based on the distribution $\{\Psi_g\}_{g=1}^3$ according to equations (21), (5), (23), and (20). Denote $\Theta' = \{E_{new}, \tau_{mr,new}, B_{new}, \pi_{E,new}\}$.

Step 6. Find the fixed point of $\Theta$ by iteration. If $\|\Theta' - \Theta\| > \delta$, set $\Theta = (\Theta + \Theta')/2$ and return to step 3. Otherwise set $\Theta^* = \Theta'$ and define

$$c_g = G_{c_g}(\text{ing}, i_h, x, h_{g-1}, i_{ma}, \varepsilon_g; \Theta^*)$$

$$l_g = G_{l_g}(\text{ing}, i_h, x, h_{g-1}, i_{ma}, \varepsilon_g; \Theta^*)$$

$$m_g = G_{m_g}(\text{ing}, i_h, x, h_{g-1}, i_{ma}, \varepsilon_g; \Theta^*)$$

$$a_g = G_{a_g}(\text{ing}, i_h, x, h_{g-1}, i_{ma}, \varepsilon_g; \Theta^*)$$

$$\text{ing}_g = G_{\text{ing}_g}(i_h, x, h_{g-1}, i_{ma}, \varepsilon_g; \Theta^*)$$

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### 6.2 Calibration

Table 1: Parameters of the model

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>$n$</td>
<td>population growth rate</td>
<td>1.25%</td>
</tr>
<tr>
<td>${a_\rho, b_\rho}$</td>
<td>parameters in survival probability</td>
<td>${0.5761, 1.0}$</td>
</tr>
<tr>
<td>$\beta$</td>
<td>discount factor</td>
<td>0.97</td>
</tr>
<tr>
<td>$\gamma_{2,g}$</td>
<td>preference on leisure</td>
<td>${1.03, 0.68, 1.03}$</td>
</tr>
<tr>
<td>$\gamma_{3,g}$</td>
<td>preference on health</td>
<td>${0.5, 0.5, 2.5}$</td>
</tr>
<tr>
<td>$\eta$</td>
<td>relative risk aversion over health</td>
<td>1.35</td>
</tr>
<tr>
<td>${A_m, \vartheta}$</td>
<td>health production</td>
<td>${1.96, 0.48}$</td>
</tr>
<tr>
<td>$\xi$</td>
<td>parameter in health on labor</td>
<td>0.1072</td>
</tr>
<tr>
<td>$\varepsilon_g$</td>
<td>health shock</td>
<td>see table 2</td>
</tr>
<tr>
<td>$\delta_h$</td>
<td>health depreciation</td>
<td>see text</td>
</tr>
<tr>
<td>$p_m$</td>
<td>price for medical service</td>
<td>see text</td>
</tr>
<tr>
<td>$A$</td>
<td>total factor productivity</td>
<td>8.0</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>labor share</td>
<td>0.66</td>
</tr>
<tr>
<td>$r$</td>
<td>interest rate</td>
<td>4%</td>
</tr>
<tr>
<td>${b_0, b_1, b_2}$</td>
<td>income tax parameters (progressive part)</td>
<td>${0.258, 0.768, 0.716}$</td>
</tr>
<tr>
<td>$\tau_y$</td>
<td>income tax parameter (proportional part)</td>
<td>4.46%</td>
</tr>
<tr>
<td>$\tau_c$</td>
<td>consumption tax</td>
<td>5.67%</td>
</tr>
<tr>
<td>$\tau_{mr}$</td>
<td>medicare tax</td>
<td>2.2%</td>
</tr>
<tr>
<td>$G$</td>
<td>government expenditure</td>
<td>18.0% of GDP</td>
</tr>
<tr>
<td>$q_{ma}(\cdot)$</td>
<td>Medicaid coverage rate</td>
<td>see text</td>
</tr>
<tr>
<td>$\pi_{ma}$</td>
<td>Medicaid premium</td>
<td>see text</td>
</tr>
<tr>
<td>$q_{mr}(\cdot)$</td>
<td>Medicare coverage rate</td>
<td>see text</td>
</tr>
<tr>
<td>$\pi_{mr}$</td>
<td>Medicare premium</td>
<td>see text</td>
</tr>
<tr>
<td>$q_E(\cdot)$</td>
<td>private insurance coverage rate</td>
<td>see text</td>
</tr>
<tr>
<td>$\pi_E$</td>
<td>private insurance premium</td>
<td>see text</td>
</tr>
</tbody>
</table>
Table 2: Health shocks by age group

<table>
<thead>
<tr>
<th>Age</th>
<th>Shock 1</th>
<th>Shock 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-44</td>
<td>-0.5</td>
<td>-10.0</td>
</tr>
<tr>
<td>45-64</td>
<td>-2.5</td>
<td>-10.0</td>
</tr>
<tr>
<td>65-85</td>
<td>-10.0</td>
<td>-20.0</td>
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</tbody>
</table>

Table 3: Coverage ratio for each expenditure grids

<table>
<thead>
<tr>
<th>bin</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>$q_E(p_{mm})$</td>
<td>0.55487</td>
<td>0.61017</td>
<td>0.65671</td>
<td>0.70503</td>
<td>0.78060</td>
</tr>
<tr>
<td>$q_{ma}(p_{mm})$</td>
<td>0.76524</td>
<td>0.81319</td>
<td>0.85763</td>
<td>0.88673</td>
<td>0.94784</td>
</tr>
<tr>
<td>$q_{mr}(p_{mm})$</td>
<td>0.49942</td>
<td>0.57952</td>
<td>0.63345</td>
<td>0.69578</td>
<td>0.77799</td>
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Table 4: Parameter values in the coverage ratio functions

<table>
<thead>
<tr>
<th></th>
<th>$q_E$</th>
<th>$q_{ma}$</th>
<th>$q_{mr}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_0$</td>
<td>0.63632(0.00144)</td>
<td>0.83671(0.00353)</td>
<td>0.51344(0.00416)</td>
</tr>
<tr>
<td>$\beta_1$</td>
<td>0.05444(0.00079)</td>
<td>0.02315(0.00165)</td>
<td>0.03223(0.00266)</td>
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<tr>
<td>$\beta_2$</td>
<td>0.00546(0.00371)</td>
<td>0.00349(0.00067)</td>
<td>0.01477(0.00094)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.0863</td>
<td>0.0475</td>
<td>0.1634</td>
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</table>
### 6.3 Numerical results

Table 5: Data vs. model

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Data</th>
<th>Benchmark</th>
</tr>
</thead>
<tbody>
<tr>
<td>All insured (in % of non-elderly)</td>
<td>83.0</td>
<td>82.9</td>
</tr>
<tr>
<td>w/ Private insurance (in % of non-elderly)</td>
<td>71.1</td>
<td>72.6</td>
</tr>
<tr>
<td>w/ Medicaid (in % of non-elderly)</td>
<td>12.9</td>
<td>10.3</td>
</tr>
<tr>
<td>Health Expenditures (in % of GDP)</td>
<td>16.3</td>
<td>16.1</td>
</tr>
<tr>
<td>Labor supply (in % of total time)</td>
<td>33.3</td>
<td>32.4</td>
</tr>
<tr>
<td>Ratio of retired to active population (in %)</td>
<td>24.3</td>
<td>24.9</td>
</tr>
<tr>
<td>Marginal income tax at 10% quantile</td>
<td>15.0</td>
<td>20.0</td>
</tr>
<tr>
<td>Marginal income tax at 50% quantile</td>
<td>26.0</td>
<td>25.4</td>
</tr>
<tr>
<td>Marginal income tax at 99% quantile</td>
<td>35.0</td>
<td>27.0</td>
</tr>
<tr>
<td>Medicare tax (in %)</td>
<td>2.9</td>
<td>2.2</td>
</tr>
<tr>
<td>Ave. insurance premium (in % of per capita GDP)</td>
<td>10.9</td>
<td>8.9</td>
</tr>
<tr>
<td>Size of Medicaid &amp; Medicare (in % of GDP)</td>
<td>4.6</td>
<td>5.2</td>
</tr>
<tr>
<td>Consumption and health expenditure profiles</td>
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<td></td>
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<tr>
<td>Gross saving rate (in %)</td>
<td>21.0</td>
<td>24.5</td>
</tr>
<tr>
<td>Mortality rate (age 25-44)</td>
<td>0.0292</td>
<td>0.0322</td>
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<tr>
<td>Mortality rate (age 45-64)</td>
<td>0.1271</td>
<td>0.1343</td>
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</table>