Cross-subsidization in employer-based health insurance and the effects of tax subsidy reform

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Abstract

A major source of insurance coverage for non-elderly adults in the US is employer-based health insurance market. *Every* participant of this market gets a tax subsidy since premiums are excluded from taxable income. However, people have different incentives to participate in the employer-based pool - since premiums are independent of individual risk, high-risk individuals receive implicit cross-subsidies from low-risk individuals. In this paper we explore several ways to reform the tax subsidy by taking this implicit cross-subsidization into account. We construct a general equilibrium heterogeneous agents model and calibrate it using the Medical Expenditure Panel Survey Dataset. We find that even though the complete elimination of the tax subsidy leads to the unraveling of the employer-based pool, there is still room for substantial savings by targeting the tax subsidy. More specifically, the same level of risk-sharing in the employer-based market can be achieved at one third of the current costs if i) the tax subsidy is targeted only towards low-risk people who have weak incentives to participate in the pool, and ii) employer-based insurance premiums become age-adjusted. To improve welfare outcome of this reform the tax subsidy should also be extended to low-income individuals.

Keywords: health insurance, tax subsidies, risk sharing, general equilibrium

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1 Introduction

Most of the non-elderly adults in the US (63%) purchase health insurance in the employer-based market.[1] An important feature of this market is community rating, i.e. the insurance premiums are independent of the health and age of individuals. In order for the community-rated market to provide good risk-sharing there should be a significant number of healthy people who are willing to participate. In the employer-based market an important incentive to participate is provided by tax subsidies: employer-based premiums are excluded from federal and state taxes. In 2009 the costs of this subsidy amounted to \$260 billion, making it the largest of the tax expenditures by the federal government and the third largest expenditure on health care after Medicare (\$400 billion) and Medicaid (\$300 billion).[2]

In this paper we ask whether it is possible to reduce spending on tax subsidies without destroying the employer-based pool. Our question is motivated by the observation that *every* participant in the employer-based market gets a tax subsidy but people have different incentives to participate in this pool. The employer-based pool involves sizeable cross-subsidization from people with low expected medical costs (young and healthy) to people with high expected medical costs (old and unhealthy). The former group pays more and the latter group pays less for their health insurance than they would pay if insurance premiums are adjusted for individual risks. As a consequence, people with high expected medical costs have stronger incentives than people with low expected medical costs to join the pool. Based on this observation we explore several ways to better target tax subsidies and evaluate the effects of these alternative subsidy schemes on tax expenditures and risk-pooling in the employer-based market.

Our approach is based on a quantitative heterogeneous agents model augmented with medical spending shocks. In the model, people can buy insurance against these shocks in the individual or employer-based markets. An important difference between these two markets is that in the former the premiums are risk-adjusted while in the latter there is community-rating, meaning that healthy and unhealthy people are charged the same premium. People are heterogeneous in their expected medical costs which creates different incentives to participate in the community-rated market: people with low expected costs may prefer to buy risk-adjusted insurance (or self-insure) while people with high expected costs may prefer to participate in the community-rated pool. We also model the differential treatment of health insurance embedded in the tax code: employer-based premiums are excluded from taxable income while individual market premiums are not. We calibrate the model using the Medical Expenditure Panel Survey (MEPS) dataset by reproducing the empirical life-cycle patterns of employment and insurance coverage as

[1] Own calculations based on the Medical Expenditure Panel Survey (MEPS) dataset.
[2] Gruber, (2011).

well as the key aggregate statistics in the U.S.

Our findings are as follows. First, we show that if tax exclusion is substituted by a *direct* subsidy that is targeted only at people with weak incentives to participate in the employer-based pool, the costs of subsidizing people with employer-based insurance can be decreased by 74% without any damage to the risk-sharing. To achieve this outcome the amount of the direct subsidy should depend on the risk-adjusted premium of each individual. Even higher cost savings can be achieved if premiums in the group market become age-adjusted, i.e. premiums can vary with age (but not with health). Since medical costs increase quickly with age, community rating involves a sizeable cross-subsidization from the young to the old. Therefore, a large amount of direct subsidies is needed in order to motivate young people to participate in this pool. Allowing the premiums to be age-adjusted reduces the size of cross-subsidization inside the pool, thus decreasing the amount of direct subsidies needed to hold the pool together.

Second, using results from the direct subsidy scheme we explore how to reform the current tax exclusion in order to obtain a similar outcome. We find that the reform that maintains good risk-sharing in the employer-based pool while significantly reducing the tax expenditures consists of two steps: i) allowing the premiums in the employer-based market to be age-adjusted, and ii) giving tax subsidy only to those participants of the employer-based pool who currently have low medical spending.[3] Under this reform the spending on the tax subsidy constitutes only a third (34.6%) of the amount in the baseline economy and the tax rate decreases by one percentage point, while the take-up rate of the employer-based insurance slightly increases (97.1% comparing to 94.2% in the baseline). In contrast, if tax subsidy is completely eliminated the take-up rate goes down to 6.3%. We repeat the analysis assuming the health reform described in the Affordable Care Act (ACA) is implemented and find that the proposed tax subsidy reform achieves a similar outcome.

Finally, our welfare analysis shows that the proposed tax subsidy reform achieves much higher welfare gains if low-income people (those with income below 200% of the Federal Poverty Line) are also allowed to keep the tax subsidy. This is because the best risk-pooling is achieved when tax subsidies are targeted at low-risk people whereas the best welfare outcomes are achieved when tax subsidies are targeted at low-income people.

Several studies examine the effects of the tax exclusion reform but none of them investigates the possibilities of targeting the tax subsidy. Gruber (2011) uses a micro-simulation model to evaluate the effect of tax exclusion removal and finds that this reform substantially increases government revenue yet significantly decreases the insurance coverage. Azawa and Fang (2012) focus on firms' decisions to offer health insurance and

[3]Since medical expenditures are persistent people with low current medical expenses have lower expected expenses and thus they drive down the average premium in the employer-based market.

find that removal of tax exclusion slightly reduces the number of firms offering employer-based insurance. Jeske and Kitao (2009) address this question using a stochastic aging general equilibrium model featuring individuals heterogeneous in their medical expense shocks. They find that eliminating tax exclusion results in a partial collapse of the employer-based market due to the adverse selection problem. Similar to Jeske and Kitao (2009), we focus on individual decisions related to health insurance but allow for a full life cycle and endogenous labor supply. This framework is well-suited to studying possible feedback effects through changing the composition of the ESHI pool after tax exclusion reforms which can trigger the adverse selection spiral if healthy and young participants start leaving the pool.

Our paper belongs to a growing body of literature that augments the standard incomplete market model with medical expense shocks and health insurance markets. Among others this literature includes work by Hansen et al (2011) who evaluate the quantitative effects of introducing Medicare buy-in, Hsu (2013) who studies the effect of health insurance on savings, Pashchenko and Porapakkarm (2011) who examine the importance of reclassification risk in the health insurance market.

We also contribute to the literature that examines the implications of government policies related to health and health insurance market. This includes Attanasio, Kitao and Violante (2011), Hai (2012), Kim (2012), Ozkan (2012), St-Amour (2012), Zhao (2011). More broadly, we relate to the literature that studies the life-cycle behavior of individuals in the presence of health uncertainty such as Capatina (2011), De Nardi et al (2010), French and Jones (2011), Kopecky and Koreshkova (2012), and Prados (2012).

The paper is organized as follows. Section 2 describes a simple model that illustrates the intuition behind our results. Section 3 introduces the full model. Section 4 describes our calibration. Section 5 evaluates the performance of the baseline model. Section 6 describes the results. Section 7 concludes.

2 Simple Model

In this section we construct a simple model to illustrate the intuition behind our results. In this simple framework we show how different subsidy schemes can be used to keep together an insurance pool of individuals who are heterogeneous in their risks.

Consider a continuum of individuals who differ in their expected medical costs. We denote an actuarial fair insurance price of an individual i by p_i. Assume p_i is uniformly distributed over the interval $[0, p_H]$, $p_i \sim F(p)$. If all individuals participate in one insurance pool, the price in this pool will be equal to $\overline{p} = \int_0^{p_H} p dF(p) = \frac{p_H}{2}$. However, this pool is unstable because individuals with $p_i < \overline{p}$ want to drop out.[4] To prevent the unraveling we need to introduce subsidies. First, we consider the case where the size of the subsidy cannot be differentiated, i.e. every individual gets the same subsidy s. In order to ensure full participation the subsidy must be equal to $\overline{p}$ to make an individual with the lowest $p_i = 0$ indifferent between staying or leaving, i.e. $s = \overline{p}$. The total spending on subsidies ($TotSubs_1$) is equal to

$$TotSubs_1 = \int_0^{p_H} s dF(p) = \frac{p_H^2}{2}.$$

Second, consider the situation where the size of the subsidy can be differentiated. In this case each individual gets a subsidy $s_i = max\{0, \overline{p} - p_i\}$. Thus, only individuals with $p_i < \overline{p}$ will get the subsidy and the size of the subsidy decreases in p_i. The total spending on subsidies is equal to

$$TotSubs_2 = \int_0^{p_H} s_i dF(p) = \frac{p_H^2}{8}.$$

Note that the total spending on subsidies can be reduced by four times by taking into account that individuals differ in their incentives to participate in the pool.

Now assume that there are two insurance pools instead of one: people with $p_i < \overline{p}$ participate in the first pool, and people with $p_i \geq \overline{p}$ - in the second. The prices in the first pool ($\overline{p}_1$) and in the second pool ($\overline{p}_2$) are determined in the following way:

$$\overline{p}_1 = \frac{1}{\Pr(p < \overline{p})} \int_0^{\overline{p}} p dF(p) = \frac{p_H}{4} \quad \text{and} \quad \overline{p}_2 = \frac{1}{\Pr(p \geq \overline{p})} \int_{\overline{p}}^{p_H} p dF(p) = \frac{3p_H}{4}$$

Consider the total subsidy spending needed to ensure full participation in each pool. If the subsidy is uniform, every individual in the first pool should get a subsidy equal to $\overline{p}_1 - 0 = \frac{p_H}{4}$, and that in the second pool should receive $\overline{p}_2 - \overline{p} = \frac{p_H}{4}$. Thus, the total spending needed to keep the pools together are:

$$TotSubs_3 = \frac{p_H}{4} \int_0^{\overline{p}} dF(p) + \frac{p_H}{4} \int_{\overline{p}}^{p_H} dF(p) = \frac{p_H^2}{4}$$

In case of the differentiated subsidy, people in the first pool get a subsidy equal to $s_i^1 = max\{0, \overline{p}_1 - p_i\}$ and people in the second pool - $s_i^2 = max\{0, \overline{p}_2 - p_i\}$. The total spending on subsidies is equal to

[4] We assume individuals are free to buy health insurance at risk-adjusted prices.

$$TotSubs_4 = \int_0^{\overline{p}} s_i^1 dF(p) + \int_{\overline{p}}^{\overline{p}_H} s_i^2 dF(p) = \frac{p_H^2}{16}$$

Table 1 summarizes the total subsidy spending in the four cases considered above. An important result is that moving from the uniform to differentiated subsidy can substantially reduce the total spending needed to ensure the full participation in the pool. These savings arise from withdrawing subsidies from people who are willing to participate even when they are not subsidized, i.e. people with $p_i > \overline{p}$. Another result is that it is much cheaper to ensure full participation if there are two smaller insurance pools instead of one big pool. This is because in the two smaller pools people are less heterogeneous in their risks, thus the size of cross-subsidization from low risk to high risk is smaller. In particular, in the one big pool the difference in risk-adjusted premiums between the highest and the lowest risks is p_H, while that in the two smaller pools is $\overline{p} = p_H - \overline{p} = \frac{p_H}{2}$. Therefore, a smaller direct subsidy is needed to make low-risk people willing to cross-subsidize high-risk people.

	One Pool	Two pools
Uniform subsidy	$p_H^2/2$	$p_H^2/4$
Differentiated subsidy	$p_H^2/8$	$p_H^2/16$

Table 1: Total spending on subsidies for different subsidy schemes

3 Baseline Model

3.1 Households

3.1.1 Demographics and preferences

The economy is populated by overlapping generations of individuals. An individual lives to a maximum of N periods. During the first $R-1$ periods of life an individual can choose whether to work or not; at age R all individuals retire. We denote the labor supply decision of a household by l_t, $l_t \in \{0, \overline{l}\}$.

Agents are endowed with one unit of time that can be used for either leisure or work. There is a fixed cost of work $\phi_{t,e}$ treated as a loss of leisure. Thus a working individual' leisure time can be expressed as $1 - \overline{l} - \phi_{t,e}$. The fixed cost of work depends on age (t) and education (e). In addition, individuals in bad health incur higher costs of work: $\phi_{t,e} = \phi_1(t,e) + \phi_2(t,e)\mathbf{1}_{\{health=bad\}}$ where $\mathbf{1}_{\{.\}}$ is an indicator function mapping to one if its argument is true, while $\phi_1(t,e)$ and $\phi_2(t,e)$ are non-negative functions.

We assume the Cobb-Douglas specification for preferences over consumption and leisure:

$$u(c_t, l_t) = \frac{\left(c_t^{\chi}\left(1 - l_t - \phi_{t,e}\mathbf{1}_{\{l_t>0\}}\right)^{1-\chi}\right)^{1-\sigma}}{1-\sigma}.$$

Here χ is a parameter which determines the relative importance of consumption, and σ is the risk-aversion over the consumption-leisure composite.

Agents discount the future at the rate β and survive till the next period with conditional probability ζ_t, which depends on age and health. We assume that the savings (net of out-of-pocket medical expenses) of each household who does not survive are equally allocated among all survived agents of a working age within the same educational group. The population grows at the rate η.

3.1.2 Health expenditures and health insurance

In each period an agent faces a stochastic medical expenditure shock x_t which evolves according to a Markov process $\mathcal{G}(x_{t+1}|x_t, t)$. We categorize individuals into two groups based on their medical expenses. Individuals with low medical expenses ($x_t \leq \overline{x_t}$) are referred to as "healthy"or "people in good health", while individuals with high medical expenses ($x_t > \overline{x_t}$) are referred to as "unhealthy"or "people in bad health". Here $\overline{x_t}$ is a threshold separating people into these two groups.

Every working age individual can buy health insurance (HI) against a medical shock in the individual health insurance market. The price of health insurance in the individual market is a function of the agent's current medical shock and age, and is denoted by $p_I(x_t, t)$.

In each period with some probability $Prob_t$ an agent of working age gets an offer to buy employer-sponsored health insurance (ESHI). The variable g_t characterizes the status of the offer: $g_t = 1$ if an individual gets an offer, and $g_t = 0$ if he does not. All participants of the employer-based pool are charged the same premium p regardless of their current medical expenses and age. An employer pays a fraction ψ of this premium. If the worker chooses to buy group insurance, he only pays $\overline{p}$ where:

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

Low-income individuals of working age can obtain their health insurance from Medicaid for free. There are two pathways to qualify for Medicaid. First, an individual can become eligible if his total income is below threshold y^{cat}. Second, an individual can become eligible through the Medically Needy program. This happens if his total income minus medical expenses is below threshold y^{need} and his assets are less than the limit k^{pub}.

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

$$i_t = \left\{ \begin{array}{ccl} 0 & ; & \text{if uninsured} \\ 1 & ; & \text{if insured by Mediciad} \\ 2 & ; & \text{if privately insured} \end{array} \right\}$$

All types of insurance contracts - group, individual, and public - provide only partial insurance against medical expenditure shocks. We denote the fraction of medical expenditures covered by the insurance contract by $q(x_t, i_t)$. This fraction is a function of medical expenditures and the type of insurance of a household.

All retired households are enrolled in the Medicare program. The Medicare program charges a fixed premium of p_{med} and covers a fraction q_{med} of medical costs.

3.1.3 Labor income

Households differ by their educational attainment e. Educational attainment can take two values: $e = 1$ corresponds to the absence of any degree, whereas $e = 2$ corresponds to at least a high-school degree.[5] Earnings are equal to $\widetilde{w} z_t^{e,x} l_t$, where $\widetilde{w}$ is wage and $z_t^{e,x}$ is the idiosyncratic productivity that depends on educational level (e), age (t) and medical expenses (x_t) of an individual.

3.1.4 Taxation and social transfers

All households pay an income tax that consists of two parts: a progressive tax denoted by $\mathcal{T}(y_t)$ and a proportional tax denoted by τ_y.[6] The taxable income y_t is based on both labor and capital income. Working households also pay payroll taxes, namely Medicare tax (τ_{med}) and Social Security tax (τ_{ss}). The Social Security tax rate for earnings above $\overline{y}_{ss}$ is zero. The U.S. tax code allows each household to subtract out-of-pocket medical expenditures that exceed 7.5% of their income when the taxable income is calculated. In addition, the ESHI premium ($\overline{p}$) is excluded from the taxable income for both income and payroll taxes. Consumption is taxed at a proportional rate τ_c.

We also assume a public safety-net program, T_t^{SI}. The program guarantees that every household will have a minimum consumption level at $\underline{c}$. This reflects the option available to U.S. households with a bad combination of income and medical shocks to rely on public transfer programs such as food stamps, Supplemental Security Income, and un-

[5] We allow for educational heterogeneity because the data shows that people without any degree have substantially lower income and lower ESHI coverage than people with at least a high school degree.

[6] The progressive part $\mathcal{T}(y_t)$ approximates the actual income tax schedule in the U.S., while the proportional tax represents all other taxes that we do not model explicitly. In this approach we follow Jeske and Kitao (2009).

compensated care.[7] Retired households receive Social Security benefits ss_e that depend on educational attainment e.

3.1.5 Optimization problem

Working age households $(t < R)$ The state variables for the working age household's optimization problem are capital ($k_t \in \mathbb{K} = R^+ \cup \{0\}$), medical cost shock ($x_t \in \mathbb{X} = R^+ \cup \{0\}$), idiosyncratic labor productivity ($z_t^{e,x} \in \mathbb{Z} = R^+$), ESHI offer status ($g_t \in \mathbb{G} = \{0,1\}$), health insurance status ($i_t \in \mathbb{I} = \{0,1,2\}$), educational attainment ($e \in \mathbb{E} = \{1,2\}$) and age ($t$).

In each period a household chooses consumption (c_t), labor supply (l_t), savings (k_{t+1}), and health insurance status for the next period (i'_H). If an individual is eligible for Medicaid, he can get free public insurance (we call this option M). If he works in a firm offering ESHI, he can buy a group insurance (G). In addition, everyone can choose to be uninsured (U), or buy individual insurance (I). We can summarize those choices as follows. If an individual is eligible for Medicaid:

$$i'_H = \left\{ \begin{array}{ll} \{M, I, G\} & ; \text{if } \ g_t = 1 \text{ and } l_t > 0 \\ \{M, I\} & ; \text{if } \ g_t = 0 \text{ or } l_t = 0 \end{array} \right\}. \tag{1}$$

Otherwise

$$i'_H = \left\{ \begin{array}{ll} \{U, I, G\} & ; \text{if } \ g_t = 1 \text{ and } l_t > 0 \\ \{U, I\} & ; \text{if } \ g_t = 0 \text{ or } l_t = 0 \end{array} \right\}. \tag{2}$$

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

$$V_{t,e}\left(k_t, x_t, z_t^{e,x}, g_t, i_t\right) = \max_{k_{t+1}, c_t, l_t, i'_H} \quad u\left(c_t, l_t\right) + \beta\zeta_t E_t V_{t+1,e}\left(k_{t+1}, x_{t+1}, z_{t+1}^{e,x}, g_{t+1}, i_{t+1}\right) \tag{3}$$

subject to

$$k_t\left(1+r\right) + \widetilde{w}\ z_t^{e,x} l_t + T_t^{SI} + Beq_e = \left(1+\tau_c\right) c_t + k_{t+1} + x_t\left(1 - q\left(x_t, i_t\right)\right) + P_t + Tax \tag{4}$$

[7] In 2004 85% of uncompensated care were paid by the government. The major portion is sourced from the disproportionate share hospital (DSH) payment (Kaiser Family Foundation, 2004).

$$\widetilde{w} = \left\{ \begin{array}{lcl} w & ; & \text{if } g_t = 0 \\ (w - c_E) & ; & \text{if } g_t = 1 \end{array} \right\} \tag{5}$$

$$P_t = \left\{ \begin{array}{ccl} 0 & ; & \text{if } i'_H \in \{U, M\} \\ p_I(x_t, t) & ; & \text{if } i'_H = I \\ \overline{p} & ; & \text{if } i'_H = G \end{array} \right\} \tag{6}$$

$$i_{t+1} = \left\{ \begin{array}{l} 0 \;;\; \text{if } i'_H = U \\ 1 \;;\; \text{if } i'_H = M \\ 2 \;;\; \text{if } i'_H \in \{I, G\} \end{array} \right\} \tag{7}$$

$$Tax = \mathcal{T}(y_t) + \tau_y y_t + \tau_{med}\left(\widetilde{w} z_t^{e,x} l_t - \overline{p}\mathbf{1}_{\{i'_H=G\}}\right) + \tau_{ss}\min\left(\widetilde{w} z_t^{e,x} l_t - \overline{p}\mathbf{1}_{\{i'_H=G\}}, \overline{y}_{ss}\right) \tag{8}$$

$$y_t = rk_t + \widetilde{w} z_t^{e,x} l_t - \overline{p}\mathbf{1}_{\{i'_H=G\}} - \max\left(0, x_t\left(1 - q\left(x_t, i_t\right)\right) - 0.075\left(\widetilde{w} z_t^{e,x} l_t + rk_t\right)\right) \tag{9}$$

$$T_t^{SI} = \max\left(0, (1 + \tau_c)\underline{c} + x_t\left(1 - q\left(x_t, i_t\right)\right) + Tax - \widetilde{w} z_t^{e,x} l_t - k_t(1 + r) - Beq_e\right). \tag{10}$$

An individual is eligible for Medicaid if

$$\left\{ \begin{array}{cc} y_t^{tot} \leq y^{cat} & \text{or} \\ y_t^{tot} - x_t\left(1 - q\left(x_t, i_t\right)\right) \leq y^{need} & \text{and } k_t \leq k^{pub} \end{array} \right\}$$

$$y_t^{tot} = rk_t + \widetilde{w}\; z_t^{e,x} l_t$$

The conditional expectation on the right-hand side of Equation (3) is over $\left\{x_{t+1}, z_{t+1}^{e,x}, g_{t+1}\right\}$. Equation (4) is the budget constraint and Beq_e is accidental bequest. In Equation (5), w is wage per effective labor unit. If the household has an ESHI coverage, his employer pays a part of his insurance premium. We assume that the employer who offers ESHI passes these costs onto the employees by deducting an amount c_E from the wage per effective labor unit, as shown in (5). Equation (7) maps the current HI choice into the next period HI status. In Equation (8), the first two terms are income taxes and the last two terms are payroll taxes.[8] Note that contributions by both the employer and employee towards the ESHI premium are excluded from the taxable income.

Retired households For a retired household ($t \geq R$) the state variables are capital (k_t), medical expenses shock (x_t), educational attainment (e), and age (t).[9]

$$V_{t,e}(k_t, x_t) = \max_{k_{t+1}, c_t} \quad u(c_t, 0) + \beta\zeta_t E_t V_{t+1,e}(k_{t+1}, x_{t+1}) \tag{11}$$

[8]In practice, employers contribute 50% of Medicare and Social Security taxes. For simplicity, we assume that employees pay 100% of payroll taxes.

[9]The problem of a newly retired household is slightly different since he is still under insurance coverage from the previous period. Thus, i_t is an additional state variable and out-of-pocket medical expenses are $x_t(1 - q(x_t, i_t))$.

subject to

$$k_t\,(1+r) + ss_e + T_t^{SI} = (1+\tau_c)\,c_t + k_{t+1} + x_t\,(1-q_{med}) + p_{med} \ + Tax$$
$$Tax = \mathcal{T}\,(y_t) + \tau_y y_t$$
$$y_t = rk_t + ss_e - \max\left(0, x_t\,(1-q_{med}) - 0.075\,(ss_e + rk_t)\right)$$
$$T_t^{SI} = \max\left(0, (1+\tau_c)\,\underline{c} + x_t\,(1-q_{med}\,(x_t)) + Tax + p_{med} - ss_e - k_t\,(1+r)\right).$$

Distribution of households To simplify the notation, let $\mathbb{S}$ define the space of a household's state variables, where $\mathbb{S} = \mathbb{K}\times\mathbb{Z}\times\mathbb{X}\times\mathbb{G}\times\mathbb{I}\times\mathbb{E}\times\mathbb{T}$ for working-age households and $\mathbb{S} = \mathbb{K}\times\mathbb{X}\times\mathbb{E}\times\mathbb{T}$ for retired households. Let $\mathbf{s}\in\mathbb{S}$, and denote by $\Gamma(\mathbf{s})$ the distribution of households over the state-space.

3.2 Production sector

There are two stand-in firms which act competitively. Their production functions are Cobb-Douglas, $AK^{\alpha}L^{1-\alpha}$, where K and L are aggregate capital and aggregate labor and A is the total factor productivity. The first stand-in firm offers ESHI to its workers but the second one does not. Under competitive behavior, the second firm pays each employee his marginal product of labor. Since capital is freely allocated between the two firms, the Cobb-Douglas production function implies that the capital-labor ratios of both firms are the same. Consequently, we have

$$w = (1-\alpha)\,AK^{\alpha}L^{-\alpha}, \tag{12}$$
$$r = \alpha AK^{\alpha-1}L^{1-\alpha} - \delta, \tag{13}$$

where δ is the depreciation rate.

The first firm has to partially finance the health insurance premium for its employees. The cost is passed on to its employees through a wage reduction. In specifying this wage reduction, we follow Jeske and Kitao (2009) . The first firm subtracts an amount c_E from the marginal product per effective labor unit. The zero profit condition implies

$$c_E = \frac{\psi p\left(\int \mathbf{1}_{\{i'_H(\boldsymbol{s})=G\}}\Gamma\,(\boldsymbol{s})\right)}{\int l_t z_t^{e,x}\mathbf{1}_{\{g_t=1\}}\Gamma\,(\boldsymbol{s})}. \tag{14}$$

The numerator is the total contributions towards insurance premiums paid by the first firm. The denominator is the total effective labor working in the first firm.

3.3 Insurance sector

Health insurance companies in both private and group markets act competitively. We assume that insurers can observe all state variables that determine the expected medical expenses of the individuals. Based on this assumption and the zero profit conditions we can write the insurance premiums in the following way:

$$p_I(x_t, t) = (1+r)^{-1}\gamma EM(x_t, t) + \pi \tag{15}$$

for the non-group insurance market and

$$p = (1+r)^{-1}\frac{\gamma\left(\int \mathbf{1}_{\{i'_H(\mathbf{s})=G\}} EM(x_t, t)\,\Gamma(\boldsymbol{s})\right)}{\int \mathbf{1}_{\{i'_H(\mathbf{s})=G\}}\Gamma(\boldsymbol{s})} \tag{16}$$

for the group insurance market. Here, $EM(x_t, t)$ is the expected medical cost of an individual of age t with current medical costs x_t that will be covered by the insurance company:

$$EM(x_t, t) = \int x_{t+1} q(x_{t+1}, 2)\, \mathcal{G}(x_{t+1}|x_t, t).$$

γ is a markup on prices due to the administrative costs in the individual and group markets; π is the fixed costs of buying an individual policy.[10] The premium in the non-group insurance market is based on the discounted expected medical expenditure of an individual buyer. The premium for group insurance is based on a weighted average of the expected medical costs of those who buy group insurance.

3.4 Government constraint

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

$$\int [Tax(\boldsymbol{s}) + \tau_c c_t(\boldsymbol{s})]\,\Gamma(\boldsymbol{s}) - G = \tag{17}$$

$$\int_{t\geq R} [ss_e + q_{med}x_t - p_{med}]\,\Gamma(\boldsymbol{s}) + \int T_t^{SI}\Gamma(\boldsymbol{s}) + \int_{t<R} \mathbf{1}_{\{i'_H=M\}} q(x_t, 1)\, x_t \Gamma(\boldsymbol{s})$$

The left-hand side is the total tax revenue from all households net of the exogenous government expenditures (G). The first term on the right-hand side is the net expenditures on Social Security and Medicare for retired households. The second term is the costs of guaranteeing the minimum consumption floor for households. The last term is the costs of Medicaid.

[10]Fixed costs capture the difference in overhead costs for individual and group policies.

3.5 Definition of stationary competitive equilibrium

Given the government programs $\{\underline{c}, ss_e, q_{med}, p_{med}, y^{cat}, y^{need}, k^{pub}, G\}$, the fraction of medical costs covered by private insurers and Medicaid $\{q(x_t, i_t)\}$, and the employers' contribution (ψ), the competitive equilibrium of this economy consists of a set of time-invariant prices $\{w, r, p, p_I(x_t, t)\}$, wage reduction $\{c_E\}$, households' value functions $\{V_{t,e}(\boldsymbol{s})\}$, decision rules of working-age households $\{k_{t+1}(\boldsymbol{s}), c_t(\boldsymbol{s}), l_t(\mathbf{s}), i'_H(\boldsymbol{s})\}$ and retired households $\{c_t(\boldsymbol{s}), k_{t+1}(\boldsymbol{s})\}$ as well as the tax functions $\{\mathcal{T}(y), \tau_y, \tau_{med}, \tau_{ss}, \tau_c\}$ such that the following conditions are satisfied:

1. Given the set of prices and the tax functions, the decision rules solve the households' optimization problems in equations (3) and (11).
2. Wage (w) and rent (r) satisfy equation (12) and (13), where

$$\begin{aligned} K &= \int k_{t+1}(\boldsymbol{s})\Gamma(\boldsymbol{s}) + \int_{t<R} \left[\mathbf{1}_{\{i'_H(\mathbf{s})=G\}} p + \mathbf{1}_{\{i'_H(\mathbf{s})=I\}}(p_I(x,t)-\pi)\right]\Gamma(\boldsymbol{s}), \\ L &= \int_{t<R} z_t^{e,x} l_t(\mathbf{s})\Gamma(\boldsymbol{s}). \end{aligned}$$

3. c_E satisfies equation (14), thus the firm offering ESHI earns zero profit.
4. The non-group insurance premiums $p_I(x_t, t)$ satisfy equation (15), and the group insurance premium satisfies equation (16), so health insurance companies earn zero profit.
5. The tax functions $\{\mathcal{T}(y), \tau_y, \tau_{med}, \tau_{ss}, \tau_c\}$ balance the government budget (17).

4 Data and calibration

4.1 Data

We calibrated the model using the Medical Expenditure Panel Survey (MEPS) dataset. The MEPS contains detailed records on demographics, income, medical costs and insurance for a nationally representative sample of households. It consists of two-year overlapping panels and covers the period of 1996-2008. We use nine waves of the MEPS between 1999 and 2008.

The MEPS links people into one household based on their eligibility for coverage under a typical family insurance plan. This Health Insurance Eligibility Unit (HIEU) defined in the MEPS dataset corresponds to our definition of a household. All statistics we use were computed for the head of the HIEU. We define the head as the male with the highest income in the HIEU. If the HIEU does not have a male member, we assign the female with the highest income as its head. We use the longitudinal weights provided in the MEPS to compute all the statistics. Since each wave represent population each year, the weight of each individual was divided by nine in the pooled sample.

In our sample we include all household heads who are at least 24 years old and have non-negative labor income (to be defined later). We use 2002 as the base year. All level variables were normalized to the base year using the Consumer Price Index (CPI).

4.2 Demographics, preferences and technology

In the model, agents are born at the age of 25 and can live to a maximum age of 99. The model period is one year so the maximum lifespan N is 75. Agents retire at the age of 65, so R is 41.

To adjust conditional survival probabilities ζ_t for the difference in medical expenses we follow Attanasio et al. (2011). In particular, we use Health and Retirement Survey (HRS) and MEPS to estimate the difference in survival probabilities for people in different medical expense categories and use it to adjust the male life tables from the Social Security Administration.[11] The population growth rate was set to 1.35% to match the fraction of people older than 65 in the data.

We set the consumption share in the utility function χ to 0.6 which is in the range estimated by French (2005).[12] The parameter σ is set to 5 which corresponds to the risk-aversion over consumption equal to 3.4 which is in the range commonly used in the life-cycle literature.[13] The discount factor β is calibrated to match the aggregate capital output ratio of 3. We set the labor supply of those who choose to work ($\bar{l}$) to 0.4

Fixed leisure costs of work $\phi_{t,e}$ are calibrated to match the employment profiles in each educational and health group.[14] More specifically, we assume that the fixed costs for people in good health $\phi_1(t, e)$ do not vary with age and use this parameter to match the employment rate for the age group 55-59 for each educational group. For the additional fixed costs of people with bad health $\phi_2(t, e)$, we assume it is a linear function of age. For each educational group we adjust the intercept and the slope of this function to match two moments: the employment rate of people in the 25-29 and 55-59 age groups who have bad health. The resulting fixed costs are presented in Table 2.

The Cobb-Douglas function parameter α is set at 0.33, which corresponds to the

[11] More details are available in Pashchenko and Porapakkarm (2013b).

[12] Given that we have indivisible labor supply we cannot pin down this parameter using a moment in the data.

[13] The relative risk aversion over consumption is given by $-cu_{cc}/u_c = 1 - \chi(1 - \sigma)$.

[14] We define a person as employed if he works at least 520 hours per year, earns at least \$2,678 per year in base year dollars (this corresponds to working at least 10 hours per week and earning a minimum wage of \$5.15 per hour), and does not report being retired or receiving Social Security benefits.

	High-school dropouts	HS and College graduates
ϕ_1	0.2800	0.2650
ϕ_2 intercept	0.0200	0.0450
ϕ_2 slope	0.0008	0.0025

Table 2: Parameters characterizing disutility from work

capital income share in the US. The annual depreciation rate δ is calibrated to achieve an interest rate of 4% in the baseline economy. The total factor productivity A is set such that the total output equals one in the baseline model.

4.3 Insurance status

In the MEPS the question about the source of insurance coverage is asked retrospectively for each month of the year. We define a person as having employer-based insurance if he reports having ESHI for at least eight months during the year (variables PEGJA-PEGDE). The same criterion is used when defining public insurance (variables PUBJA-PUBDE) and individual insurance status (variables PRIJA-PRIDE). For those few individuals who switch sources of coverage during a year, we use the following definition of insurance status. If a person has both ESHI and individual insurance in one year, with each coverage lasting for less than eight months but the total duration of coverage for more than eight months, we classify this person as individually insured. Likewise, when a person has a combination of individual and public coverage that altogether lasts for more than eight months, we define that individual as having public insurance.[15]

4.4 Medical expenditures

Medical costs in our model correspond to the total paid medical expenditures in the MEPS dataset (variable TOTEXP). These include not only out-of-pocket medical expenses but also the costs covered by insurers. In our calibration medical expense shock is approximated by a 5-state discrete Markov process. For each age, we divide the medical expenditures into 5 bins, corresponding to the 30th, 60th, 90th and 99th percentiles. We set $\overline{x_t}$ that separates people into different medical expenses categories to the 90th percentile of medical expenses distribution of the corresponding age. In other words, people whose medical expenses are in the lowest three bins are classified as healthy, while people whose medical expenses are in the highest two bins are classified as unhealthy. To construct the transition matrix we measure the fraction of people who

[15]The results do not significantly change if we change the cutoff point to 6 or 12 months.

move from one bin to another between two consecutive years separately for people of working age (25-64) and for retirees (older than 65).

We use MEPS to estimate the fraction of medical expenses covered by insurance policies $q(x_t, i_t)$.[16] For retired households we set q_{med} to 0.5 following Jeske and Kitao (2009) and Attanasio et al (2011).

4.5 Government

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

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

This functional form is commonly used in the quantitative macroeconomic literature (for example, Conesa and Krueger, 2006; Jeske and Kitao, 2009). In this functional form a_0 controls the marginal tax rate faced by the highest income group, a_1 determines the curvature of marginal taxes and a_2 is a scaling parameter. We set a_0 and a_1 to the original estimates as in Gouveia and Strauss (1994), which are 0.258 and 0.768 correspondingly. The parameter a_2 is used to balance the government budget in the baseline economy. We set proportional income tax τ_y to 6.62% to match the fact that around 65% of tax revenues come from income taxes that are approximated in our calibration by the progressive function $\mathcal{T}(y)$. When considering policy experiments we keep a_2 as in the baseline economy, and adjust τ_y to balanced the government budget.

The minimum consumption floor $\underline{c}$ is set to $2,700 following the estimates of De Nardi et al. (2010). The Social Security replacement rates were set to 40% and 30% of the average labor income for people with low and high education correspondingly, reflecting the progressivity of the system.

Medicaid eligibility rules were taken from the data. The income eligibility threshold for general Medicaid (y^{cat}) is set to 64% of FPL which is the median value for this threshold among all states in 2009. The income eligibility threshold for the Medically Needy program (y^{need}) and asset test for this program (k^{pub}) are set to 53% of FPL and $2,000 correspondingly. These numbers are equal to the median values for the corresponding eligibility criteria in 2009 in the states that have Medically Needy program.

The Medicare, Social Security and consumption tax rates were set to 2.9%, 12.4% and 5.67% correspondingly. The maximum taxable income for Social Security is set to $84,900. The fraction of exogenous government expenses in GDP is 18%.

[16] The calibration of medical expenses shock and insurance reimbursement ratios is detailed in Pashchenko and Porapakkarm (2013b).

4.6 Insurance sector

The share of health insurance premium paid by the firm (ψ) was chosen to match the aggregate ESHI take-up rate.[17] The resulting number (76.3%) is consistent with the one observed in the U.S. economy, which is in the range of 75-85% (Kaiser Family Foundation, 2009).

We set the proportional loads for group and individual insurance policies (γ) to 1.11 (Kahn et al., 2005). The fixed costs of buying an individual policy π is set to \$23 to match the aggregate fraction of people with individual insurance.

4.7 Offer rate

We assume that probability of getting an offer of ESHI coverage is a logistic function:

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

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

$$u_t = \eta_0^e + \eta_1^e \log(inc_t\ ) + \eta_2^e \left[\log(inc_t\ )\right]^2 + \eta_3^e \left[\log(inc_t\ )\right]^3 + \eta_4^e \mathbf{1}_{\{g_{t-1}=1\}} + \Theta^e D_t \qquad (18)$$

Here $\eta_0^e, \eta_1^e, \eta_2^e, \eta_3^e, \eta_4^e$ and Θ^e are education-specific coefficients, inc_t is individual labor income (normalized by the average labor income), and D_t is a set of year dummy variables. To construct the initial offer rate (g_1 in equation (18)) we run a separate logistic regression for people aged 24-26 which includes dummies for medical expenses categories but not offer in the previous period.[18]

4.8 Labor income

We divide households into two educational groups: high-school dropouts and people with at least a high-school degree. The fraction of each group in the population is 15% and 85% correspondingly. Individuals with different education and health have different productivity, which is specified as follows:

$$z_t^{e,x} = \lambda_t^{e,x} \exp(v_t) \exp(\xi_t) \qquad (19)$$

[17] In this paper we use the term "take-up rate"only in relation to the employer-based market, and it defines the fraction of people among those with an ESHI offer who choose to buy group insurance.

[18] In all experiments the offer probability is the same as in the baseline. Aizawa and Fang (2012) use an equilibrium search model to examine how firms offering ESHI would respond if the tax subsidy is removed. They find only a small change in the equilibrium offer rate.

where $\lambda_t^{e,x}$ is the deterministic function of age, education and health, and

$$v_t = \rho v_{t-1} + \varepsilon_t, \quad \varepsilon_t \sim N(0, \sigma_\varepsilon^2) \tag{20}$$

$$\xi_t \sim N(0, \sigma_\xi^2)$$

For the persistent shock v_t we set ρ to 0.98 and σ_ε^2 to 0.018 following the incomplete market literature (Storesletten et al (2004); Hubbard et al (1994); Erosa et al (2011); French (2005)). We set the variance of the transitory shock (σ_ξ^2) to 0.1 which is in the range estimated by Erosa et al (2011). In our computation we discretize the stochastic shocks v_t and ξ_t using the method in Floden (2008).[19] To construct the distribution of newborn individuals, we draw v_1 in equation (20) from $N(0, 0.124)$ distribution following Heathcote et al. (2010).

To identify the deterministic part of productivity $\lambda_t^{e,x}$ we need to take into account the fact that in the data we only observe labor income of workers but not the potential income of non-workers. At the same time, the fraction of non-workers is substantially higher among people with low education and those with bad health. To address this problem we adopt the method developed by French (2005) which is described in detail in Pashchenko and Porapakkarm (2013a). We start by estimating the average labor income profiles of workers from the MEPS dataset.[20] Then we estimate $\lambda_t^{e,x}$ in equation (19) inside the model in order to reproduce the average labor income profile of *workers* as in the data. The advantage of this approach is that we can reconstruct the productivity $z_t^{e,x}$ of individuals *whom we do not observe working in the data.* Figure (1) plots the labor income profiles of *workers* in the data and in the model, and compares them with the average potential labor income computed for *everyone* in the model. Our estimates show that the average labor income that includes potential income of non-workers is lower than that of only workers because people with low productivity tend to drop out from the employment pool. In other words, if we do not use the correction described above we would *overestimate* the labor income for non-participating individuals and this bias is especially strong in the case of unhealthy people and people at pre-retirement age. We also find that unhealthy people are inherently less productive. The drop in productivity due to bad health depends on age but it can be as high as 22% for high-school dropouts and as high as 15% for people with at least a high-school degree.

Table 9 in Appendix A summarizes the parametrization of the baseline model.

[19] We use 9 grid points for v_t and 2 grid points for ξ_t. The grid of v_t is expanding to capture the increasing cross-sectional variance. Our discretized process for v_t generates the autocorrelation of 0.98 and 0.016 for its innovation variance.

[20] Household labor income is defined as the sum of wages (variable WAGEP) and 75% of the income from business (variable BUSNP). This definition is the same as the one used in the Panel Study of Income Dynamics Dataset (PSID), which has been commonly used for income calibration in the macroeconomic literature.

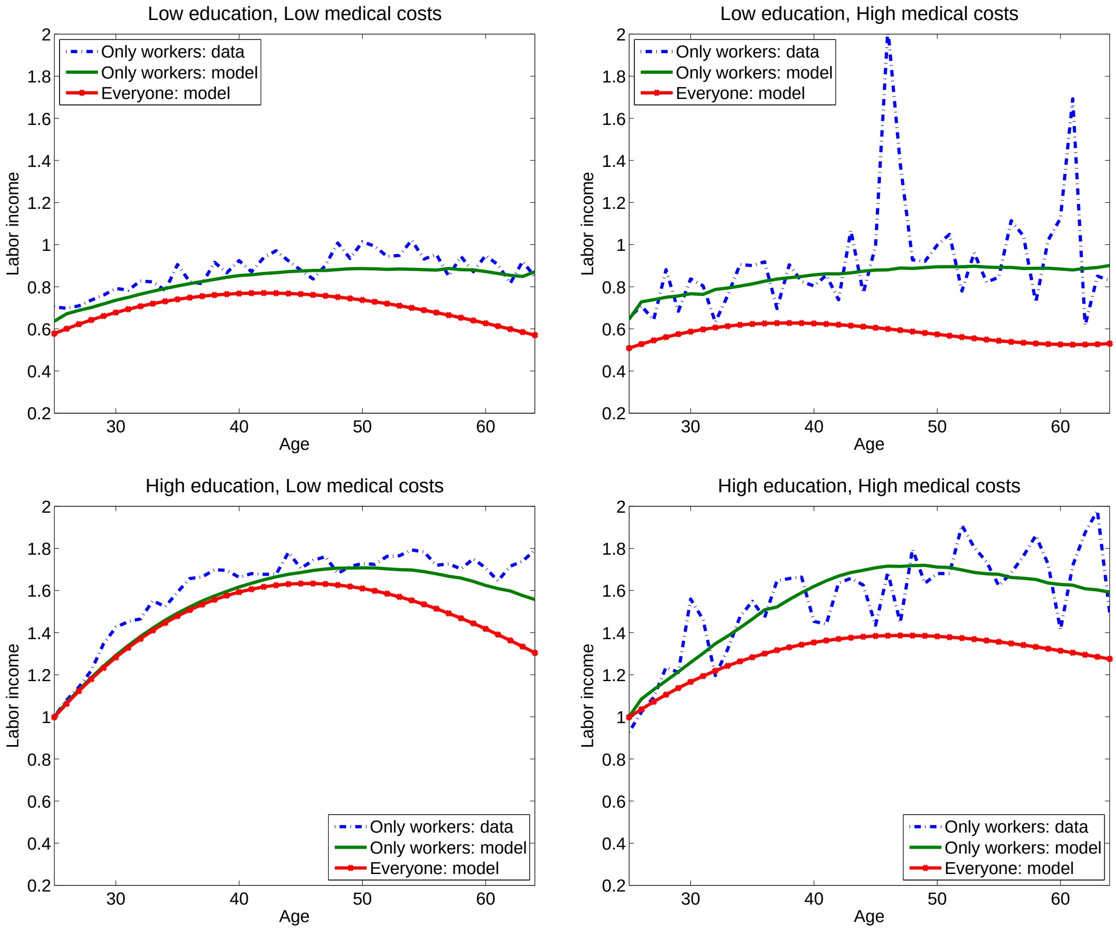

Figure 1: Average labor income of workers (data and model) and of everyone (model). The later profile takes into account the unobserved productivity of those who do not work.

5 Baseline model performance

Figure (2) compares the employment profiles observed in the data with the ones generated by the model. The model closely tracks the employment profiles for each educational and health group though it slightly overestimates the employment rate of the youngest group because we abstract from labor market frictions.

Table 3 compares the aggregate health insurance statistics generated by the model with the ones observed in the data. The model was calibrated to match the ESHI take-up rates and individual insurance rates. However, the model also produces the fraction of uninsured and publicly insured close to the data. The last four columns of Table 3 show insurance statistics by educational groups. Our model does not target any of these statistics, but it still fares well along these dimensions.

The top panel of Figure (3) plots the percentages of the uninsured and publicly insured in the model and in the data respectively. For both educational groups, the model can capture the corresponding empirical profiles. There is an overprediction in the number of

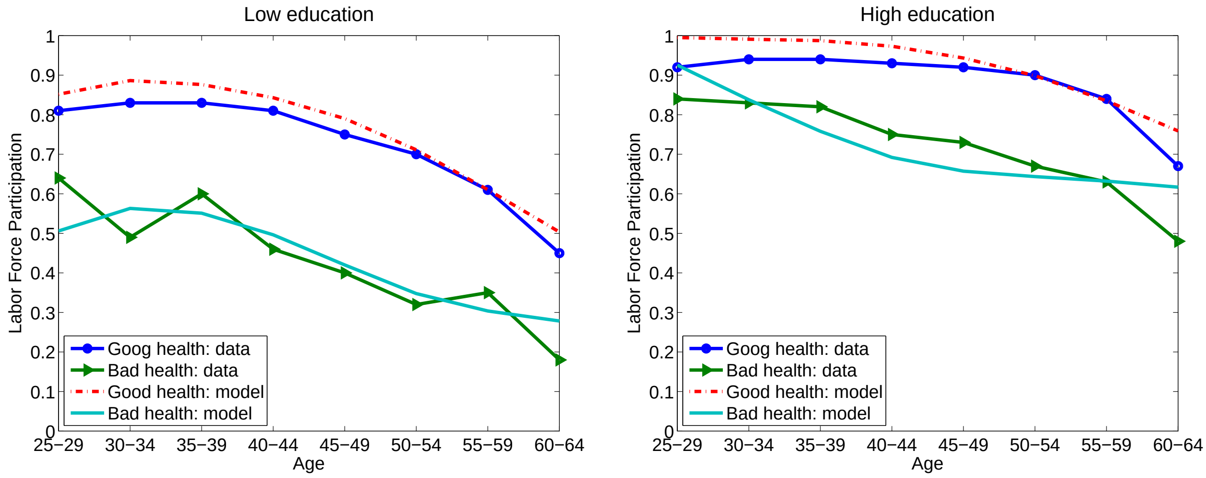

Figure 2: Employment profiles for people with low education (left panel) and high education (right panel): data vs. model

	All		Low education		High education	
	Data	Model	Data	Model	Data	Model
Insured by ESHI (%)	63.0	64.4	33.3	29.1	68.5	70.6
Individually insured (%)	7.6	7.3	5.5	3.8	8.0	8.0
Uninsured (%)	20.2	19.7	39.5	43.2	16.6	15.6
Publicly insured (%)	9.2	8.6	21.7	23.8	6.9	5.9
ESHI take-up rate (%)	94.3	94.2	85.9	81.6	93.9	95.3
Offer rate (%)	67.6	68.3	38.8	35.7	72.9	74.1
Group premium/avg.income (%)	7.0	6.7	-	-	-	-

Table 3: Insurance statistics: data vs. model

publicly insured for people of preretirement age due to our simplified Medicaid eligibility criteria. The bottom panel of Figure (3) compares the life-cycle profiles of the fraction of people with private insurance for different educational groups in the model and in the data. The model reproduces the general life-cycle pattern and differences in educational group in insurance rates. However, for low educated people it underestimates the fraction of people with ESHI among the older group due to our overestimation of the fraction of the publicly insured for this age category. The model also tends to underpredict the fraction of people with individual insurance among young low-educated people because we assume only one choice of plan in the individual insurance market.

Our model also produces a reasonable number of poor people: the fraction of people (including retirees) with assets less than \$1,000 is 10.9%. In the data this number is 11.1% in 2004 according to Survey of Consumer Finance (SCF) (Kennickell, 2006).

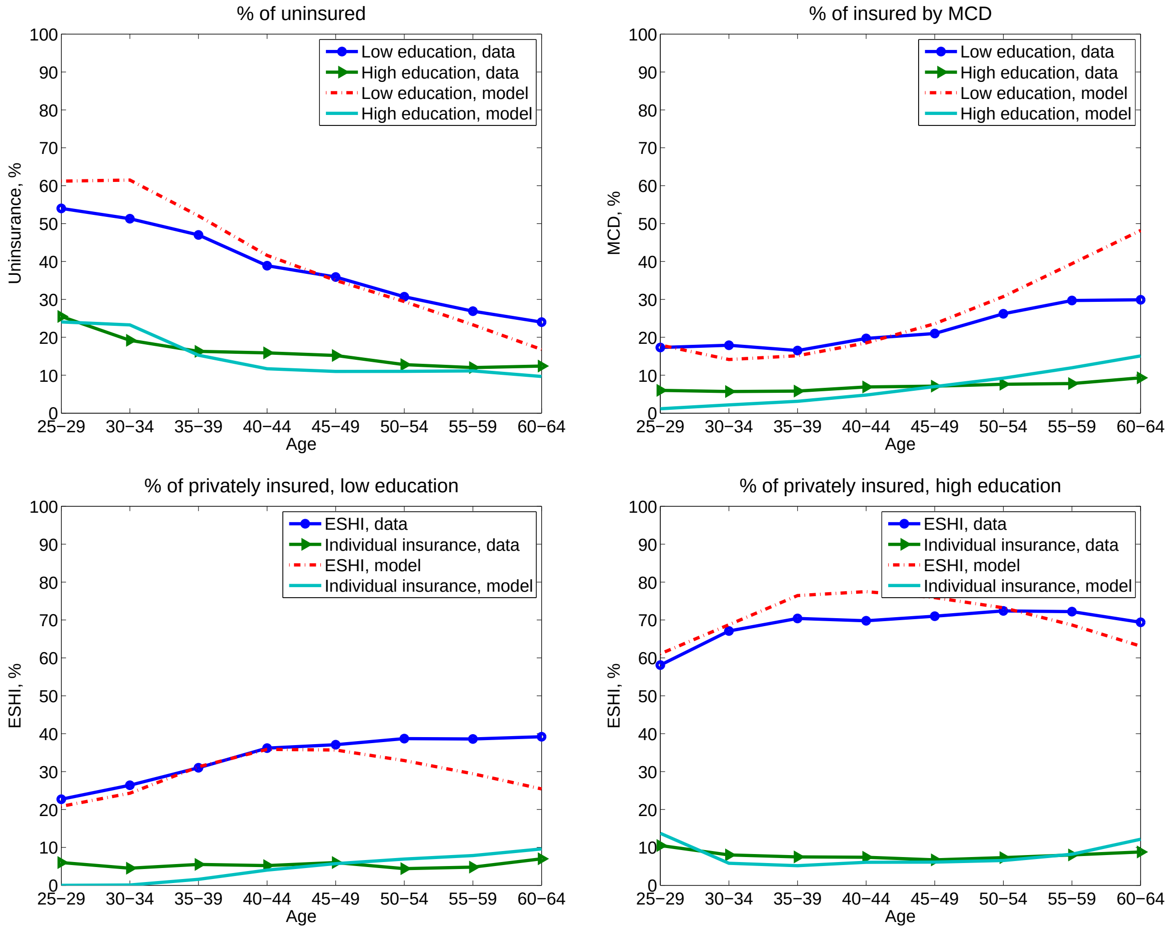

Figure 3: Percent of uninsured and publicly insured (top panel) and privately insured (bottom panel), data vs. model

6 Results

This section is organized as follows. In Section 6.1 we illustrate the role of the existing tax subsidies in preventing the ESHI pool from unraveling. Next, in Section 6.2, we construct the following policy experiment: instead of the current tax exclusion we introduce an individually-adjusted *direct* subsidy that only goes to individuals who will leave the pool if not subsidized. The subsidy scheme in this experiment is comparable to the simple example in Section 2. Our main goal in constructing this experiment is to understand how the ESHI take-up and total subsidy spending change comparing to the baseline economy. In Section 6.3, we propose a reform of the current tax subsidy that aims to mimic the allocation of transfers as in the case of the individually-adjusted direct subsidies. The effects of this tax subsidy reform after the implementation of the Affordable Care Act (ACA) is discussed in Section 6.4. Finally, we discuss the welfare effects of this tax reform in Section 6.5.

6.1 The role of the tax exclusion in keeping the ESHI pool together

To understand the role of the current tax subsidies in keeping the ESHI pool together we consider an experiment where the ESHI premium is not excluded from taxable income. In this case the total taxable income in equation (9) is determined in the following way:

$$y_t^{ND} = rk_t + \widetilde{w} z_t^{e,x} l_t + \psi p \mathbf{1}_{\{i'_H = G\}} - \max\left(0, x_t\left(1 - q\left(x_t, i_t\right)\right) - 0.075\left(\widetilde{w} z_t^{e,x} l_t + rk_t\right)\right) \quad (21)$$

The total amount of tax is now determined as follows:

$$Tax^{ND} = \mathcal{T}\left(y_t^{ND}\right) + \tau_y y_t^{ND} + \tau_{med}\left(\widetilde{w} z_t^{e,x} l_t + \psi p \mathbf{1}_{\{i'_H = G\}}\right) + \tau_{ss} \min\left(\widetilde{w} z_t^{e,x} l_t + \psi p \mathbf{1}_{\{i'_H = G\}}, \overline{y}_{ss}\right) \quad (22)$$

Note that comparing to equations (8) and (9), people who buy ESHI now have to count both the employee's and employer's contributions as a part of their taxable income. For people who do not buy ESHI, the tax code stays the same.

	ESI take-up (%)			Subsidy	Tax rate	Agg K
	All	LE	HE	(% BS)	τ_y (%)	(% BS)
Baseline	94.2	81.6	95.3	100.0	6.86	100.0
1. No tax subsidy	6.3	4.0	6.5	0.0	6.07	103.8
2. Differentiated subs.	85.4	53.3	88.1	26.4	5.93	100.4
3. Differentiated subs.+age-adjusted CR	90.0	62.6	92.4	16.2	5.66	102.1

Table 4: The effect of differentiated tax subsidy: the ESHI take-up rates and total spending on subsidies

	Employment (%)			Insurance (%)		
	All	LE	HE	Unins	Indiv	MCD
Baseline	89.7	75.6	92.2	19.7	7.3	8.6
1. No tax subsidy	86.9	74.7	89.2	62.4	22.7	10.8
2. Differentiated subs.	88.8	75.3	91.2	26.3	7.0	9.2
3. Differentiated subs.+age-adjusted CR	88.6	75.4	90.9	23.4	7.1	9.2

Table 5: The effect of differentiated tax subsidy: employment and insurance

The first row of Table 4 shows that the elimination of tax exclusion results in almost complete unraveling in the employer-based market: the take-up rate drops from 94.2% to 6.3%. At the same time, the uninsurance rate increases to 62.4% (Row 1 of Table 5). This suggests that tax subsidies are an important mechanism to maintain good risk-sharing inside the employer-based pool.[21]

[21] Jeske in Kitao (2009) find that the elimination of tax exclusion results in a less dramatic unraveling of the ESHI market. This difference is due to the fact that they abstract from age dimension which substantially reduces the amount of cross-subsidization in the ESHI pool.

Figure (4) illustrates the intuition behind this result. This figure compares the risk-adjusted premiums in the individual market with out-of-pocket costs of ESHI in the baseline economy. The out-of-pocket costs of ESHI (p^{OOP}) are defined in the following way:

$$p^{OOP} = p(1 - \psi) + \Delta Tax$$

where $p(1-\psi)$ is the employee's contribution and ΔTax is the difference in tax payments resulting from the purchase of ESHI, $\Delta Tax = Tax^{i'_H=G} - Tax^{i'_H \neq G}$. If the ESHI premium is excluded from the taxable income, an individual can save on taxes by buying employer-based insurance, i.e. $\Delta Tax < 0$. If the tax exclusion is removed, an individual buying ESHI has to pay additional taxes since employers' contributions are now counted as taxable income, i.e. $\Delta Tax > 0$.

The difference between the out-of-pocket ESHI costs with and without tax exclusion is large enough to trigger the adverse selection spiral. As shown in Figure (4), for young people in the two lowest medical expenses grids the out-of-pocket costs of ESHI exceed their risk-adjusted prices in the individual market after the tax subsidy is removed.[22] These people initiate the unraveling by dropping out of the employer-based market and this leads to an increase in the ESHI premium and further unraveling of the pool.

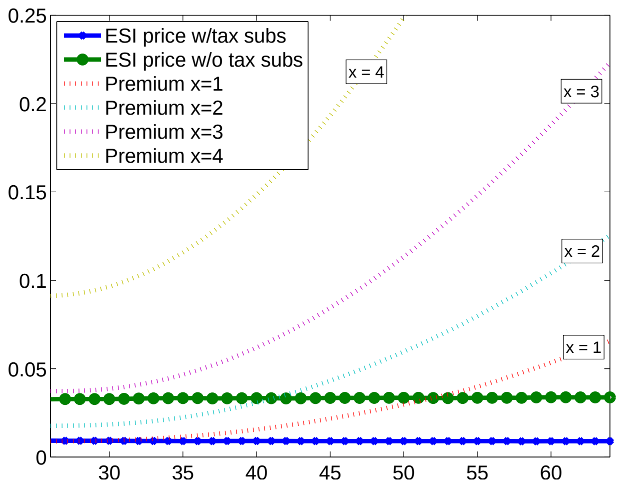

Figure 4: Individual premiums for people in different medical expense grids vs. average out-of-pocket costs of ESHI with and without tax exclusion.

Another observation from Figure (4) is that for older people and people in the high medical costs grids the out-of-pocket costs of ESHI are substantially lower than their risk-adjusted individual premiums even when tax exclusion is removed. These people enjoy large implicit cross-subsidies from people with low expected medical costs and they have incentives to buy ESHI even without tax subsidies. Figure (5) illustrates this

[22]When constructing Figure (4), the premium used to compute p^{OOP} after removing the tax exclusion is fixed as in the baseline. After the unraveling starts this price will substantially increase.

point further by showing the markup that individuals with different expected medical costs face in the ESHI pool. The markup is measured as a percentage difference between the risk-adjusted price in the individual market and the out-of-pocket costs of ESI.[23] The negative markup means that an individual is overpaying compared to his risk-adjusted price, thus cross-subsidizing other participants in the pool, whereas the positive markup means that an individual is cross-subsidized. Community rating imposes a large burden on healthy people younger than 35 years old - their markup can be as large as -250%. In contrast, people above the age of 60 with bad health enjoy a discount of around 90% off their risk-adjusted price when they participate in the group market. We will explore the possibilities of designing subsidies that take this cross-subsidization into account in the next section.

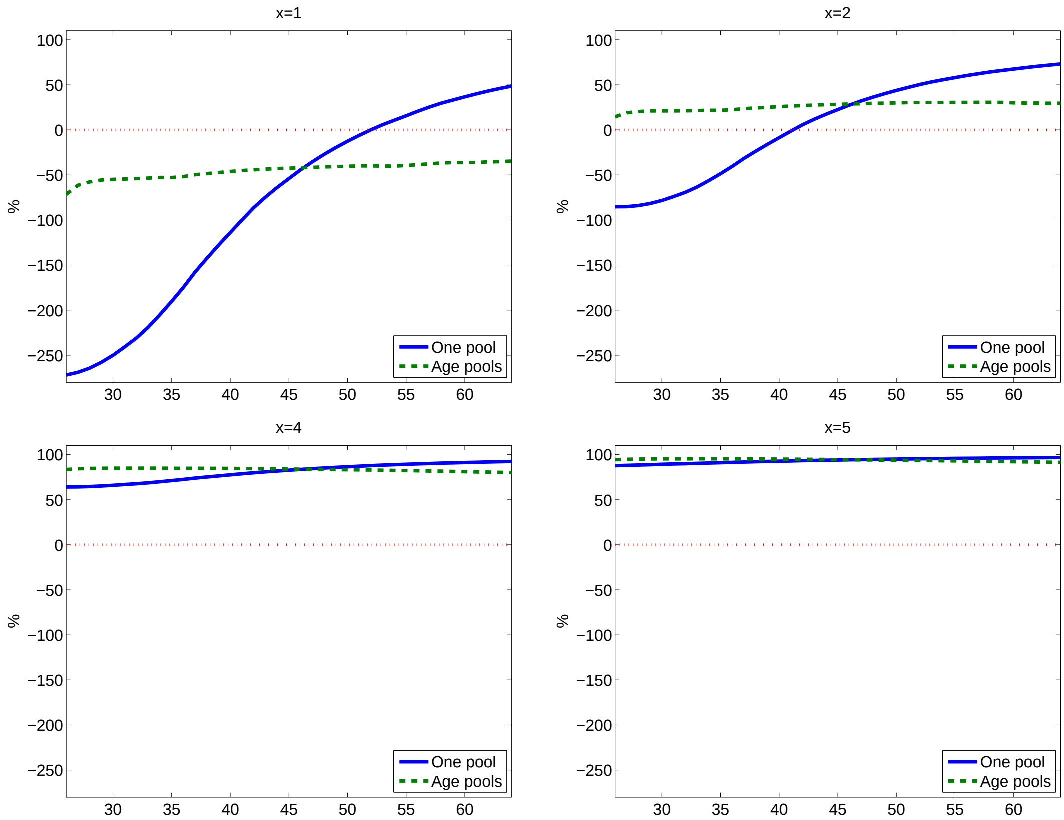

Figure 5: Markup for people in different medical expense grids in the ESHI market. The solid lines are the markup in a single pool in the baseline economy. The dashed lines are the markup in case when ESHI premiums are age-adjusted.

[23]More specifically, the markup is computed as $100\% * \dfrac{p_I(x_t, t) - p^{OOP}}{p_I(x_t, t)}$

6.2 The effects of direct differentiated subsidies

In this section we consider an alternative subsidy scheme that only targets at people with weak incentives to participate in the ESHI pool. More specifically, we remove the tax exclusion of the ESHI premium and introduce a *direct* differentiated subsidy instead. This subsidy compensates people with low expected medical costs more because in the pool they cross-subsidize people with high expected medical costs. The subsidy is determined in the following way:

$$subs_i = max\left\{0, p^{OOP} - \frac{EM(x_t,t)}{1+r}\right\}.$$

An individual with a positive subsidy receives a difference between his actuarially fair price $\frac{EM(x_t,t)}{1+r}$ and his out-of-pocket costs of ESHI, p^{OOP}. Note that only individuals who are likely to leave the pool if they are not subsidized get a positive subsidy.

The results of the implementation of this subsidy scheme are presented in the second row of Table 4. The differentiation of the subsidy results in a small decrease in the take-up rate: from 94.2% to 85.4%.[24] At the same time, the total spending on these direct subsidies represents only 26.4% of the tax expenditures used to keep the ESHI pool together in the baseline economy.[25] In other words, removing the subsidy from those who have already been cross-subsidized inside the pool results in almost the same level of risk-sharing at one fourth of the costs.

The left panel of Figure (6) illustrates how the size of the subsidy varies by age and health. Not surprisingly, people who get the highest subsidies are those younger than 35 years old and in the lowest medical cost grid. These people have the lowest expected medical expenses and are the most disadvantageous group in the employer-based pool (see the left panel of Figure (5)), and therefore they should get the highest compensation. It is important to point out that people aged over 55 and those in medical cost grids 4 and 5 never get subsidized yet they still remain in the pool. This suggests the inefficiency of uniform subsidization.

The left panel of Figure (6) illustrates that young healthy people are the most "costly"participants in the community-rated pool because they have to be subsidized a lot in order to stay in the pool. This happens because all people face the same premium in uniform community rating. Since the expected medical costs increase steeply with age

[24]Note that not all individuals are willing to buy health insurance even at actuarially fair prices. This happens because health insurance covers only part of the medical costs. At the same time, uninsured individuals can rely on government means-tested transfers provided through the consumption minimum floor. Pashchenko and Porapakkarm (2011) illustrate the effect of the consumption floor on the insurance demand in more detail.

[25]In the baseline economy the costs to keep the pool together represent the tax revenue forgone because of the tax exclusion. It is computed as follows: $\int \left[Tax^{ND}(\boldsymbol{s}) - Tax(\boldsymbol{s})\right]\Gamma(\boldsymbol{s})$. In the economy with the differentiated subsidy scheme these costs are the direct subsidy spending.

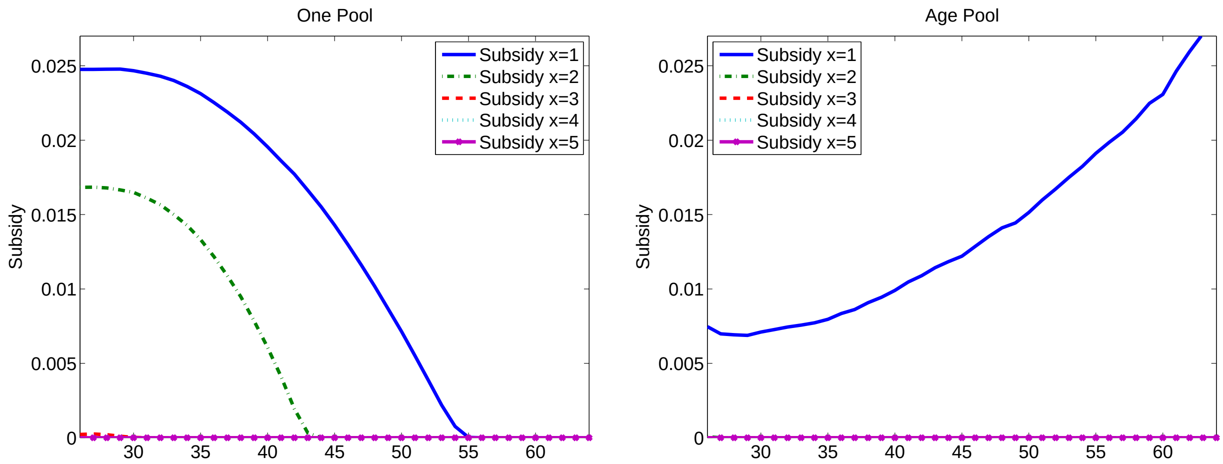

Figure 6: Differentiated subsidies in case of one pool (left panel) and age pool (right panel). On the left panel the lines for medical cost grids 3 to 5 lie on the horizon axis. On the right panel the lines for medical cost grids 2 to 5 lie on the horizon axis.

this implies a large cross-subsidization from the young to the old. The whole system of transfers inside this pool can be summarized as follows: the young cross-subsidize the old and the government directly subsidizes the young in order for them to stay in the pool. In contrast, if community rating in the ESHI market is age-adjusted, there will be no cross-subsidization from the young to the old but only from the healthy to the unhealthy. Since the difference in expected medical costs between healthy and unhealthy individuals of the same age is smaller than this difference between the healthy young and the unhealthy old, age-adjusted pools imply less cross-subsidization and thus less direct subsidies are needed to maintain a high participation rate in the pool.

In the next experiment we consider the above differentiated subsidy scheme when we introduce age-adjusted community rating in the group market, i.e. we allow the ESHI premium to depend on age (but not on the current medical costs) of an individual. Thus the ESHI premium in Eq (16) is replaced by age-dependent premium as indicated below:

$$p\left(\widehat{t}\right) = (1+r)^{-1}\gamma \frac{\left(\int_{\mathbf{t}=\widehat{t}} \mathbf{1}_{\left\{i'_H(\mathbf{s})=G\right\}} EM\left(x_t, t\right)\Gamma\left(\boldsymbol{s}\right)\right)}{\int_{\mathbf{t}=\widehat{t}} \mathbf{1}_{\left\{i'_H(\mathbf{s})=G\right\}}\Gamma\left(\boldsymbol{s}\right)}.$$

The third row in Table 4 shows that the implementation of the differentiated subsidy scheme together with the age-adjusting community rating results in the take-up rate equal to 90.0% (comparing to 94.2% in the baseline). Importantly, the total spending on subsidies now represents only 16.2% of the tax expenditures in the baseline economy. In other words, when cross-subsidization along the dimension of age is removed it is much cheaper to maintain good risk-sharing in the employer-based market. Figure (5) shows that the markup that young people face in age-adjusted community rating is much lower than that in uniform community rating. As the right panel of Figure (6) illustrates, now only people in the lowest medical cost grid can get a direct subsidy. The amount of this subsidy increases with age because the expected medical expenses of people in the first medical cost grid increase much slower with age than the average medical expenses. As they age, people who stay in the lowest medical cost grid need a higher compensation in order to agree to pool their risks with people in higher medical cost grids.

6.3 Reforming the current tax exclusion of ESHI premiums

The previous section illustrates that we can use direct differentiated subsidies to maintain good risk-sharing in the employer-based pool at relatively low costs. In this section we investigate if the current tax subsidy can be modified in order to achieve a similar outcome. Tax exclusion is a less flexible instrument than direct subsidy. However, one result from the previous section that can still be applied is that only people with weak incentives to participate in the ESHI pool should be subsidized. To mimic this result we consider a tax subsidy reform that only targets at people who receive the direct subsidy in the experiment described in Section 6.2. At the same time, we remove tax exclusion from people who do not get any direct subsidy.[26]

	ESI take-up (%)			Subsidy	Tax rate	Agg K
	All	LE	HE	(% BS)	τ_y (%)	(% BS)
Baseline (pre-ACA economy)	94.2	81.6	95.3	100.0	6.86	100.0
1. No tax subsidy	6.3	4.0	6.5	0.0	6.07	103.8
Tax subsidy only to a certain group:						
2. (x_t=1 and age$\leq$55) or (x_t=2 and age$\leq$43)	92.5	70.8	94.3	43.9	6.15	100.6
3. x_t=1 + age-adj CR	97.1	81.3	98.5	34.6	5.89	101.5

Table 6: The effects of tax subsidy reforms

The left panel of Figure (6) illustrates that in the direct differentiated subsidy scheme two groups get subsidized: people in the lowest medical expense grid and younger than 55 years old, as well as people in the second lowest medical expense grid and younger than 43 years old. To imitate these results we consider a policy where only these two groups are allowed to keep the tax exclusion. The second row of Table 6 illustrates the effect of this reform (Table 10 in Appendix B shows the effect on the employment and insurance status). Allowing young and healthy people to keep the tax exclusion prevents the ESHI pool from unraveling: the take-up rate is 92.5% which is only 2% lower than in the baseline. At the same time, the costs of the tax subsidy go down more than

[26]In this experiment the taxable income and tax payments are determined according to equations (8) and (9) for the ESHI participants that are allowed to keep the tax exclusion, and according to equations (21) and (22) for the rest of the ESHI participants.

twice comparing to the baseline level (43.9%).[27] Note that even though these savings are considerable, they are not as high as in the case of direct differentiated subsidies. This happens because the size of the tax subsidy (unlike the size of the direct subsidy) cannot be adjusted for individual risks. The left panel of Figure (6) shows that the size of the direct subsidy decreases steeply with age and this represents a significant source of savings because older people need less incentives in order to join the pool.

The results in Section 6.2 demonstrate that a high participation rate in the ESHI pool can be achieved at significantly smaller costs if community rating in the ESHI market is age-adjusted. In the next experiment we introduce age-adjusted premiums in the ESHI market. At the same time, we allow only people in the lowest medical expense grid to keep the tax exclusion since only this group receives direct subsidies in this case as shown in the right panel of Figure (6). Row 3 of Table 6 shows that this reform results in the take-up rate slightly higher than the baseline level (97.1%). At the same time, the costs of these tax subsidies represent only one third (34.6%) of the baseline level.

6.4 Elimination of the tax exclusion after the ACA

This section considers the effects of our proposed tax exclusion reform after the implementation of the ACA. The main changes that the ACA introduces to the economy are as follows. First, there will be age-adjusted community rating in the *individual* market meaning that premiums can only depend on age but not on the health conditions of individuals. Second, low-income people will get subsidies to buy health insurance in the *individual* market. The subsidy will be determined based on a sliding scale. People with income below 133% of FPL will get the highest subsidy while people with income above 400% of FPL will not get any subsidy. Third, the income eligibility threshold for the general Medicaid program (y^{cat}) will increase to 133% of FPL. Fourth, people who stay uninsured will have to pay penalties. Appendix C details how the ACA changes our baseline model.

The first row of Table 7 reports the ESHI take-up rate for the long-run equilibrium after the implementation of the ACA. Table 11 in Appendix B reports the employment and insurance statistics. We will use this economy as a reference when comparing the effect of the tax subsidy reforms after the ACA is implemented. When implementing the ACA we assume that all additional government spending needed to pay for subsidies and expanding Medicaid are financed by increasing the progressive income tax. This increase disproportionably falls on high-income people to reflect that the important source of the ACA financing comes from levying higher taxes on the rich. More specifically, we

[27] In each experiment considered in Tables 6 and 7, we evaluate the total subsidy spending (or forgone tax revenue) from $\int \left[Tax^{ND}(\boldsymbol{s}) - Tax(\boldsymbol{s})\right]\Gamma(\boldsymbol{s})$ where tax parameters are the equilibrium tax rate in that economy. Note that for individuals who are not allowed to keep the tax exclusion $Tax^{ND} = Tax$.

	ESI take-up (%)			Subsidy	Tax rate	Agg K
	All	LE	HE	(% BS)	τ_y (%)	(% BS)
Post-ACA economy	94.2	75.6	95.9	100.0	6.86	100
1. No tax subsidy	52.6	31.6	54.4	0.0	5.70	99.6
2. No tax subsidy, no penalties	5.3	3.8	5.4	0.0	6.44	104.2
Tax subsidy only to a certain group:						
3. (x_t=1 and age≤55) or (x_t=2 and age≤43)	93.6	72.5	95.5	47.0	6.32	100.1
4. x_t=1 + age-adjusted CR	94.4	74.3	96.2	35.8	6.22	101.5

Table 7: The effects of the partial removal of tax exclusion after the ACA

adjust the parameter a_0 of the tax function to balance the government budget during the implementation of the ACA. As a result, this parameter increases from 0.258 (baseline level) to 0.285. The resulting average tax rate for a person with average income increases by 1.2 percentage point.[28]

Row 1 of Table 7 shows the effects of the complete elimination of tax exclusion after the reform (Table 11 in Appendix B reports corresponding changes in the employment and insurance). In contrast to the economy before the ACA, removing tax subsidies does not lead to the full unraveling of the employer-based pool: the take-up rate decreases only to 52.6%. Row 2 of Table 7 shows that this high take-up rate is due to the penalty for being uninsured: if the penalty is removed the elimination of the tax subsidy brings the take-up rate down to 5.3%.

Row 3 of Table 7 shows the effects of the reform that allows only two groups to keep the tax exclusion: people in the lowest medical expense grid who are younger than 55 years old, as well as people in the second lowest medical expense grid who are younger than 43 years old. This tax subsidy reform results in a slightly lower take-up rate (93.6% comparing to 94.2%) but the tax expenditures constitute less than half (47%) of the post-ACA baseline level.

Row 4 of Table 7 shows the results of targeting tax exclusion only at people in the lowest grid of medical expenses combined with age-adjustment of premiums in the ESHI market. As before, this policy achieves good risk-pooling with the least costs: the take-up rate is the same as in the post-ACA baseline (around 94%) while the tax expenditures constitute 35.8% of the post-ACA baseline level.

6.5 Welfare effects

The important finding from Sections 6.3 and 6.4 is that the reform that achieves good risk-sharing in the ESHI market at the lowest costs involves two steps: i) the existing tax subsidy should be targeted only at low-risk people, and ii) ESHI premiums should

[28] For a full analysis of the effects of the ACA on the economy, see Pashchenko and Porapakkarm (2013a).

be age-adjusted. This section evaluates the welfare effects of this tax subsidy reform and compares them with those when tax exclusion is completely eliminated. Rows 1 and 4 of Table 8 show that the complete elimination of the tax subsidy results in substantial ex-ante welfare losses both in the pre-ACA and post-ACA economies: the consumption equivalent variations (CEV) are equal to -0.46% and -0.36% of the annual consumption correspondingly.[29] There is heterogeneity in welfare effects by educational group: people with high education lose around 1% of the annual consumption while people with low education gain. Many people in the latter group do not have access to the employer-based market so they do not suffer from its unraveling. Instead they can enjoy a lower tax rate due to lower government tax expenditures.

	CEV (%)			Subsidy	Tax rate	ESHI
	All	LE	HE	(%BS)	τ_y(%)	Take-up
Before ACA						
Pre-ACA baseline	-	-	-	100.0	6.86	94.2
1.No tax subsidy	-0.46	0.27	-1.08	0.0	6.07	6.03
Tax subsidy only to a certain group:						
2. x_t=1 + age-adj CR	0.18	0.41	-0.01	34.6	5.89	97.1
3. x_t=1 and income<2*FPL+age-adj CR	0.61	0.79	0.46	42.4	5.89	98.5
After ACA						
Post-ACA baseline	-	-	-	100.0	6.86	94.2
4. No tax subsidy	-0.36	0.41	-0.98	0.0	5.70	52.6
Tax subsidy only to a certain group:						
5. x_t=1 + age-adj CR	-0.15	0.16	-0.40	35.8	6.22	94.4
6. x_t=1 and income<2*FPL+age-adj CR	0.13	0.42	-0.11	42.0	6.23	94.7

Table 8: Ex-ante welfare of newborns for different policy experiments

Rows 2 and 5 of Table 8 show the welfare effects of the tax reform that combines age-adjusted community rating in the ESHI market with the removal of tax exclusion from all people except those in the lowest medical cost grid. Before the ACA this tax subsidy reform brings positive welfare gains (0.18%) while after the ACA the welfare effects become negative (-0.15%). In general, this policy withdraws subsidies from all people whose medical expenses are not in the bottom 30% of the medical expense distribution regardless of their income. However, even though the average income of the ESHI pool participants is relatively high, there is substantial income heterogeneity. The loss of

[29]Let V^B and V^E denote the value function of a newborn in the baseline and the experimental economy correspondingly. The CEV can be defined as:

$$CEV = 100 * \left[1 - \left(\frac{V^B}{V^E}\right)^{\frac{1}{\chi(1-\sigma)}}\right]$$

The resulting number represents the percentage of the annual consumption a newborn in the experimental economy is willing to give up in order to be indifferent between the baseline and experimental economies. The positive number implies welfare gains.

tax subsidies by low-income people with high medical costs negatively affects welfare. At the same time, the introduction of age-adjusted premiums in the ESHI market positively affects welfare because it results in the decrease of ESHI premiums for young people, many of whom have low income.[30] Before the implementation of the ACA the positive welfare effect from age-adjusted ESHI premiums offsets the negative welfare effect from withdrawing tax subsidies from low-income people. In contrast, after the ACA the opposite is true because the tax rate is higher, thus the size of the tax subsidy is higher as well. Withdrawing this subsidy from the low income group yields more noticeable welfare effect that cannot be fully offset by the age-adjustment of premiums in the group market.

To improve the welfare outcomes we extend the tax subsidy to people with income below 200% of FPL. Rows 3 and 6 of Table 8 show the welfare effects of this modified policy before and after the ACA. Before the ACA the resulting welfare gains increase to 0.61% and after the ACA - to 0.13%. However, tax expenditures do not increase much: before the ACA the tax expenditures increase from 34.6% to 42.4% of the baseline level and after the ACA - from 35.8% to 42.0% of the level of the post-ACA baseline. In other words, both before and after the ACA the spending on tax subsidies can be decreased by almost 60% without unraveling of the employer-based market and without decreasing the welfare. To achieve these results it is important i) to target tax subsidies at people with low expected medical expenses and people with low income, and ii) to allow for age-adjusted premiums in the group market.

7 Conclusion

In this paper we explore the possible reform of the current tax subsidy for people who buy employer-based health insurance. We show that even though the complete elimination of tax subsidies leads to the unraveling of the employer-based market, there is room for substantial savings on the tax expenditure by targeting tax subsidies. We show that good risk-pooling in the employer-based market can be achieved at much lower costs if the tax code takes into account the fact that people have different incentives to participate in the employer-based pool. In the employer-based market, high-risk people get implicit cross-subsidies from low-risk people and are willing to join the pool even without any subsidies. In contrast, for low-risk people the employer-based insurance pool is less attractive. By building on this intuition we propose a tax subsidy reform that can maintain the same level of risk-pooling in the group market as in the baseline economy but at one third of the costs. In order to achieve these results only people in the

[30] The introduction of the age-adjusted community rating in the ESHI market in the baseline economy results in ex-ante welfare gains equivalent to 0.27% of the annual consumption.

bottom 30% of medical expenses distribution should be allowed to keep the tax exclusion. In addition, the premiums in the group market should be age-adjusted in order to remove cross-subsidies from the young to the old and to make the ESHI pool more attractive for the young. In order to improve the welfare outcome of this reform it is important to extend tax exclusion to people with income below 200% of FPL which increase the tax expenditure to around 40% of the baseline level.

A Summary of the parametrization of the baseline model

Parameters set outside the model			
Parameter name	Notation	Value	Source
Risk aversion	σ	5	-
Consumption share	$\varkappa$	0.6	French (2005)
Cobb-Douglas parameter	α	0.33	Capital share in output
Labor supply	$\bar{l}$	0.4	-
Cutoff medical expenses	$\overline{x_t}$	90th percentile	-
Consumption floor	$\underline{c}$	\$2,700	De Nardi et al., 2010
Tax function parameters:	a_0	0.258	Gouveia and Strauss (1994)
	a_1	0.768	Gouveia and Strauss (1994)
Social Security replacement rates:			
Below High-School	ss_1	40%	-
High-School & College	ss_2	30%	-
Insurance loads	γ	1.11	Kahn et all (2005)
Medicaid income threshold:			
Medicaid	y^{cat}	64%	Data
Medically Needy	y^{need}	53%	Data
Asset test for Medically Needy	k^{pub}	\$2,000	Data
Medicare premium	p^{med}	\$1,055	Total premiums =2.11% of Y
Productivity shock:			
Persistence parameter	ρ	0.98	Heathcote et al (2010)
Variance of innovations	σ_ε^2	0.018	Heathcote et al (2010)
Variance of transitory shock	σ_ξ^2	0.10	Erosa et al (2011)

Parameters used to match some targets			
Parameter name	Notation	Value	Source/Target
Discount factor	β	0.992	$\frac{K}{Y} = 3$
Depreciation rate	δ	0.07	$r = 0.04$
Population growth	η	1.35%	% of people older than 65
Tax function parameter	a_2	0.652	Balanced government budget
Proportional tax	τ_y	6.62%	Composition of tax revenue
Fixed costs for insurance	π	\$22.7	% of individually insured
Employer contribution	ψ	76.3%	ESHI take-up rate
Fixed costs of work			Employment profiles
Healthy:			
low education	$\phi_1(1)$	0.2800	
high education	$\phi_1(2)$	0.2650	
Unhealthy, low educ:	$\phi_2(t,1)$		
intercept	-	0.0200	
slope	-	0.0008	
Unhealthy, high educ:	$\phi_2(t,2)$		
intercept	-	0.0450	
slope	-	0.0025	

Table 9: Parameters of the model

B The effect of tax exclusion reform on employment and insurance statistics

Table 10 shows the change in the insurance and employment behavior as a result of the tax subsidy reform before the ACA. Table 11 shows these changes after the ACA.

	Employment (%)			Insurance (%)		
	All	LE	HE	Unins	Indiv	MCD
Baseline	89.7	75.6	92.2	19.7	7.3	8.6
1. No tax subsidy	86.9	74.7	89.2	62.4	22.7	10.8
Tax subsidy only to a certain group:						
2. (x_t=1 and age $\leq$55) or (x_t=2 and age $\leq$43)	88.9	75.3	91.4	20.8	7.7	9.1
3. x_t=1 + age-adj CR	88.9	75.5	91.3	18.1	7.5	9.1
4. x_t=1 and income<2*FPL + age-adj CR	89.5	76.3	91.8	17.3	7.3	8.5

Table 10: The effects of tax subsidy reform before the ACA

	Employment (%)			Insurance (%)		
	All	LE	HE	Unins	Indiv	MCD
Post-ACA baseline	89.1	79.8	90.8	8.9	18.5	10.1
1. No tax subsidy	88.3	79.9	89.8	31.1	24.2	10.4
Tax subsidy only to a certain group:						
2. (x_t=1 and age$\leq$55) or (x_t=2 and age$\leq$43)	88.6	79.8	90.1	9.6	18.8	10.3
3. x_t=1 + age-adj CR	88.3	79.8	89.8	8.8	19.5	10.1
4. x_t=1 and income<2*FPL + age-adj CR	88.6	80.1	90.0	8.6	19.2	10.1

Table 11: The effects of tax subsidy reform after the ACA

C Changes introduced by the ACA

This section describes how the ACA provisions change the baseline model.

C.1 Household problem

After the reform, a working-age household may be subject to penalties if he stays uninsured or may receive subsidies to buy *individual* health insurance. In addition, more households will be eligible for Medicaid. The eligibility for subsidies and the Medicaid expansion depends on a household's total income (y_t^{tot}); whereas penalties are a function of the taxable income (y_t). We can rewrite the budget constraint of a working-age household (4) in the following way:

$$k_t\,(1+r) + \widetilde{w}\ z_t^{e,x} l_t + T_t^{SI} + Beq_e + Sub(y_t^{tot}, i'_H) = (1+\tau_c)\,c_t + k_{t+1} + \\ x_t\,(1 - q\,(x_t, i_t)) + P_t + Tax + Pen(y_t, i'_H). \tag{23}$$

Here $Sub(y_t^{tot}, i'_H)$ and $Pen(y_t, i'_H)$ are subsidies and penalties correspondingly. A household with income above 400% of the Federal Poverty Line (FPL) cannot get subsidies. People having income below 400% of FPL and receiving an ESHI offer are eligible for premium subsidies in the individual market only if their employee's contribution ($\overline{p}$) exceeds 9.5% of their total income. The subsidy structure ensures that individuals within a certain income category do not spend more than a certain fraction of their income on health insurance. More specifically, spending on individual insurance premiums is limited to the percentage of total income shown in Table 12.[31]

Maximum premium spending (% of income)	Income categories (% of FPL)
2.0	<133
3.5	133-150
5.2	150-200
7.2	200-250
8.8	250-300
9.5	300-400

Table 12: Maximum spending on individual insurance as a percentage of total income after receiving subsidies

The income eligibility threshold for the general Medicaid program is increased to 133% of FPL. There are no changes in the Medically Needy program.

An uninsured person whose insurance premium in the individual market is less than 8% of his income has to pay a penalty. The penalty is determined as

$$Pen(y_t, i'_H) = \max\{0.025 y_t, \$695\} \quad \text{if} \quad i'_H = U$$

C.2 Insurance sector after the reform

The reform imposes a heavy regulation on the individual insurance market. Insurance companies can no longer condition premiums on the current medical cost of individuals.

[31]The subsidy function specified in the Bill is slightly more complicated: for each income category it specifies the range of maximum premium spending as a fraction of income. We approximate this range by selecting the midpoint of a corresponding interval. For example, the range for the income category 133-150% of FPL is 3-4% and we approximate it by the midpoint 3.5%.

The insurance premium of an individual of age $\widehat{t}$ will be determined by

$$p_I\left(\widehat{t}\right) = (1+r)^{-1}\gamma\frac{\left(\int_{\mathbf{t}=\widehat{t}}\mathbf{1}_{\left\{i'_H(\mathbf{s})=I\right\}}EM\left(x_t,t\right)\Gamma\left(\boldsymbol{s}\right)\right)}{\int_{\mathbf{t}=\widehat{t}}\mathbf{1}_{\left\{i'_H(\mathbf{s})=I\right\}}\Gamma\left(\boldsymbol{s}\right)} + \pi.$$

Thus, after the reform the individual market premium p_I will be a function of age only.

C.3 Government constraint

We maintain the assumption that the government runs a balanced budget. This implies

$$\int\left[Tax\left(\boldsymbol{s}\right) + \tau_c c_t\left(\boldsymbol{s}\right)\right]\Gamma\left(\boldsymbol{s}\right) - G + \int_{t<R} Pen(y_t, i'_H)\Gamma\left(\boldsymbol{s}\right) =$$
$$\int_{t\geq R}\left[ss_e + q_{med}\left(x_t\right)x_t - p_{med}\right]\Gamma\left(\boldsymbol{s}\right) + \int T_t^{SI}\Gamma\left(\boldsymbol{s}\right) + \int_{t<R}\mathbf{1}_{\left\{i'_H=M\right\}}q\left(x_t,1\right)x_t\Gamma\left(\boldsymbol{s}\right)$$
$$+\int_{t<R} Sub(y_t^{tot}, i'_H)\Gamma\left(\boldsymbol{s}\right)$$

The left-hand side now has an additional source of revenue - penalties from those unwilling to purchase insurance. The right-hand side has an additional expenditure - subsidies. To balance the government budget we adjust $\mathcal{T}\left(y_t\right)$ to make it more progressive.[32] More specifically, to achieve a balanced budget in the economy with the ACA provisions in place, we adjust the parameter a_0 which controls the marginal tax rate faced by the highest income group.

[32] More specifically, the Bill increases hospital insurance payroll tax on people with income above \$200,000 by 0.9% and imposes a 3.8% tax on unearned income for higher-income tax-payers (Kaiser Family Foundation, 2011). Our calibration strategy assumes a standard log-normal income process commonly used in macro-literature, which cannot generate the empirical fraction of top earners. Because of this we increase the progressivity of the general tax code to capture the main idea of financing the reform by taxing the rich more.

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