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Optimal Health Insurance in the Presence of Risky Health Behaviors

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Abstract

This paper develops a model of risky health behaviors to explore the optimal cost-sharing mechanism in a single provider health insurance system in which everyone contributes the same amount. In this economy, health insurance provides coverage against controllable health outcomes, and idiosyncratic health shocks. The model is calibrated to the U.S. economy using the Medical Expenditures Panel Survey dataset. I find that the optimal set of policies is the one in which workers pay 30 percent of their health care bills while retirees pay 20 percent. Welfare gains mostly come from the healthy who prefers less generous health insurance policies.

Keywords: Health insurance; life cycle model; medical expenditures.
JEL Classification: D91, E60, I12

1 Introduction

The share of almost any country's income going to health expenditures is quite large, either financed by health insurance or out-of-pocket. Risky health behaviors

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include consumption of some goods that are detrimental to health and raise health care bills.[1] The goal of this paper is to provide a quantitative analysis of health insurance policy in the presence of risky health behaviors.

To do this, I incorporate risky health behaviors into a heterogeneous agent overlapping generations (OLG) model with endogenous health capital accumulation, addressing two functions of health insurance: First, it covers medical expenditures resulting from risky health behaviors; and second, it provides insurance for idiosyncratic health shocks, mostly catastrophic ones.[2]

The effect of health insurance on the demand for medical care is well examined in the literature (Arrow, 1963; Zeckhauser, 1970; Blomqvist, 1997; Feldman and Dowd, 1991; Newhouse, 1993; Cutler and Zeckhauser, 2000; Zweifel and Manning, 2000; Baicker et al., 2013; Cawley and Meyerhoefer, 2011). Many of these studies address the issue that health insurance leads to overuse of medical care due to moral hazard. Other studies estimate the optimal insurance policy as a mix of coinsurance rates and deductibles (Feldstein and Friedman, 1977; Newhouse, 1993; Manning and Marquis, 1996; Blomqvist, 1997; Eggleston, 2000). However, risky health behaviors, such as smoking and poor dietary habits, were not incorporated in the analysis of optimal health insurance in these studies.

Putting risky health behaviors into the model adds more moral hazard since insurance not only leads to overuse of medical care, but also affects people's tendency towards the consumption of risk-bearing goods. What makes an optimal policy analysis more interesting is the fact that medical expenses of people engaging in risky health behaviors are also paid by those who do not through the insurance system.

The model is calibrated to the U.S. economy, focusing on tobacco consumption as the only form of risky health behavior. Results suggest that the optimal health insurance policy consists of 30 percent coinsurance rate for the workers and 20 percent for the retirees. This set of policies brings about half a percentage point decline in medical expenditures to GDP ratio, 5 percentage points decline in the

[1] Empirical literature suggests those risky health behaviors to be costly (Rice et al., 1986; Barendregt et al., 1997; Miller et al., 1999; Warner et al., 1999; Sloan et al., 2004; Finkelstein et al., 2009), and fatal (McGinnis and Foege, 1993; Peto et al., 1994; Mokdad et al., 2005a,b; Woloshin et al., 2008; Danaei et al., 2009; Stewart et al., 2009). For a detailed discussion of the economics of risky health behaviors, see Cawley and Ruhm (2011).

[2] As to what may be considered catastrophic is usually decided by the ratio of medical expenditures to total expenditures or total income of the individual. For example, Xu et al. (2003) define catastrophic health expenditures as expenditures exceeding 40 percent of income.

ratio of smokers and a welfare gain equivalent to 3.34 percent more consumption compared to the benchmark economy with 4.5 percent and 5 percent coinsurance rates for the workers and retirees respectively. This welfare gain is largely driven by the welfare gains of the good-health agents. The intuition behind this is as follows. Since everyone in the economy contributes the same share of their income to the health insurance system, good-health people with low health maintenance costs are better off by paying a larger percentage of their medical bills in exchange for less labor income tax, which can instead go the consumption of other goods.

This work is a contribution to the recently developing macro-health literature. Several other papers in this literature study the relationship between health spending and longevity (Hall and Jones, 2007), savings and medical expenditures (Palumbo, 1999; Scholz and Seshadri, 2010; De Nardi et al., 2010); medical expenditures over the life course (Halliday et al., 2011), health spending across different income groups (Özkan, 2014; Ales et al., 2012); effects of tax policy on insurance demand (Jeske and Kitao, 2009); and the policy outcomes of the Patient Protection and Affordable Care Act (Feng, 2009; Jung and Tran, 2010; Cole et al., 2012; Pashchenko and Porapakkarm, 2013; Hansen et al., 2014). I add to this literature by explicitly modeling risky health behaviors and quantitatively analyzing the effects of health insurance policy in that setting.

The paper proceeds as follows: Section 2 introduces the model, Section 3 presents the data and the calibration steps, Section 4 provides the numerical results of the policy experiments, and Section 5 concludes.

2 Model

This section presents the OLG model that will be used to study the quantitative implications of different health insurance policies.

2.1 Demographics

Individuals live for a maximum of J years, and are heterogeneous in their health capital, $h_j \in \mathcal{H}$ where $\mathcal{H} = \{h^1, h^2, ..., h^N\}$ is the finite set of possible health capital levels. $\varphi_j(h_{j-1}, \delta_{h,j-1}, s_{j-1})$ is the conditional probability of surviving from age $j-1$ to j, that depends on the health capital, h_{j-1}, the depreciation rate of health capital, $\delta_{h,j-1}$ and health shock, s_{j-1} at age $j-1$. I am interested in steady-state properties of the model, hence drop the time subscripts.

2.2 Preferences

Individuals get utility from good consumption, c_{gj}, bad consumption, c_{bj} and their health capital.[3] They maximize the lifetime utility:

$$\max \sum_{j=1}^{J} \beta^{j-1} \left(\prod_{k=1}^{j} \varphi_k(h_{k-1}, \delta_{h,k-1}, s_{k-1}) \right) u(c_{gj}, c_{bj}, h_j) \tag{1}$$

2.3 Health Production

Following the concept of health capital introduced by Grossman (1972), health production function is given by:[4]

$$h_{j+1} = (1 - \delta_{h,j})h_j + Z h_j^{\zeta} m_{dj}^{\xi} \tag{2}$$

Individuals are ex-ante heterogeneous in initial health, h_1. Health capital depreciates at the rate $\delta_{h,j}$, and individuals can accumulate health capital by investing in health, i.e. by making medical expenditures, m_j. This process is irreversible, i.e., an individual can only invest as much as to recover from the current depreciation. Z and ξ are scale and curvature parameters for health production respectively. Parameter ζ governs the adjustment cost needed to yield higher medical expenditures for individuals with lower health capital.

2.4 Health Depreciation

Bad consumption affects the stock of health through the health depreciation rate.[5] Health shock also increases the depreciation rate.

$$\delta_{h,j} = \delta_{h,j}^{ns} + \phi_j I_{c_{bj}} + (s_j - 1)\Xi_j \tag{3}$$

ϕ_j denotes the incremental change in the depreciation rate of health for those who engage in bad consumption and Ξ_j denotes the incremental change coming

[3] Bad consumption refers to risky health behaviors that can be classified among consumption goods.

[4] Similar health production functions were used in Feng (2009), Jung and Tran (2010), Scholz and Seshadri (2010), Halliday et al. (2011) and Özkan (2014). Some of these studies use a health production function that incorporates leisure time, or time spent in health producing activities such as exercise, whereas some like Özkan (2014) uses different health production functions for physical and preventive health.

[5] The notion of incorporating bad consumption in such a model was first used by He et al. (2014)

from the health shock. $I_{c_{bj}}$ is an indicator function which takes the value 1 if bad consumption exists and 0 otherwise. $s_j = 1$ when health shock hits and $s_j = 0$ otherwise.

2.5 Survival Probability

The probability of survival from age j to age $j+1$ is a function of the health capital net of depreciation and health shock at age j, and is denoted by $\varphi_{j+1}(h_j, \delta_{h,j}, s_j)$. The survival probability function is governed by the cumulative Weibull distribution function:[6]

$$\varphi_{j+1}(h_j, \delta_{h,j}, s_j) = \left[1 - exp(-\psi\left[(1-\delta_{h,j})h_j\right]^{\theta})\right] \tag{4}$$

ψ and θ are parameters in the cumulative Weibull distribution.

2.6 Health Care System

There is a single-payer health care system where the government is the provider of health insurance. Working age individuals pay a fraction, ω_w, of their medical expenses whereas retired individuals pay ω_r of them. These expenditures are financed by taxes on good consumption, bad consumption and labor income.

2.7 Social Security

Following İmrohoroğlu et al. (1995), the benefits that the retired households get are defined as a proportion of their average lifetime earnings from working, which is given by:

$$b = \rho \frac{\sum_{j=1}^{J_R-1} w\epsilon_j}{J_R - 1} \tag{5}$$

where ρ is the replacement ratio.

2.8 Individuals' Dynamic Problem

We can denote the individual's life time maximization problem given in (1) as a discrete time dynamic programming problem and maximize the following value func-

[6] Feng (2009) and Scholz and Seshadri (2010) use similar functions for survival probability But here the survival probability depends on health capital net of depreciation and before health investment.

tion:

$$V_j(a_j, h_j, s_j) = \max_{c_{gj}, I_{c_{bj}}, m_j, a_{j+1}} \Big\{ u(c_{gj}, c_{bj}, h_j) + \beta\varphi_{j+1}(h_j, \delta_{h,j}, s_j)\big[Pr(s_{j+1}=0)V(a_{j+1}, h_{j+1}, 0) + Pr(s_{j+1}=1)V_{j+1}(a_{j+1}, h_{j+1}, 1)\big]\Big\} \tag{6}$$

subject to

$$(1+\tau_{c_g})c_{gj} + (1+\tau_{c_b})c_{bj} + \omega m_j + a_{j+1} = (1+r)a_j + y_j \tag{7}$$

$$y_j = \begin{cases} (1-\tau_n)w\epsilon_j & \text{if} \quad j = 1, ..., J_R - 1 \\ b & \text{if} \quad j = J_R, ..., J \end{cases} \tag{8}$$

$$\omega = \begin{cases} \omega_w & \text{if} \quad j = 1, ..., J_R - 1 \\ \omega_r & \text{if} \quad j = J_R, ..., J \end{cases} \tag{9}$$

$$c_{bj} = \nu * I_{c_{bj}} \tag{10}$$

$$h_{j+1} = (1-\delta_{h,j})h_j + Zh_j^{\zeta} m_{dj}^{\xi} \tag{11}$$

$$\delta_{h,j} = \delta_{h,j}^{ns} + \phi_j I_{c_{bj}} + (s_j - 1)\Xi_j \tag{12}$$

$$\varphi_{j+1}(h_j, \delta_{h,j}, s_j) = \left[1 - exp(-\psi\Big[(1-\delta_{h,j})h_j\Big]^{\theta})\right] \tag{13}$$

where τ_{c_g} and τ_{c_b} are tax rates on good and bad consumption respectively, a_{j+1} is the saving for the next period. Individuals supply labor inelastically in the market and earn an income of $w\epsilon_j$ where w is the market wage rate and ϵ_j is the age specific efficiency of labor. τ_n is the labor income tax rate. r is the market interest rate on risk-free bonds. I_{sj} is an indicator function that takes the value 1 if the health shock hits. $Pr(s_{j+1} = 1)$ is the probability that the health shock will hit at age $j+1$. ν denotes the amount of income spent on bad consumption if the individual chooses to consume those goods.

2.9 Government Budget Constraint

Revenues from taxes on good consumption, excise taxes from bad consumption and labor income taxes as well as assets left by the deceased are collected by the central government and are used to finance health care expenditures, discretionary government spending and social security benefits. Labor income tax, τ_n is set to clear the government budget constraint. Let's define $\mu(h,j)$ as the measure of age j individuals with health capital h. Let's further define $\mathcal{J}_{\mathcal{W}} = \{1, 2, ..., J_{R-1}\}$, $\mathcal{J}_{\mathcal{R}} = \{J_R, J_R + 1, ..., J\}$ and $\mathcal{J} = \{1, 2, ..., J\}$. And $\mathcal{H}$ is the set of possible health capital levels as described earlier. So the following budget constraint has to clear.

$$T_{c_g} + T_{c_b} + T_n + A = G + B + (1-\omega)M \tag{14}$$

$$T_{c_g} = \tau_{c_g} \sum_{h\in\mathcal{H}} \sum_{j\in\mathcal{J}} \mu(h,j) c_{g,hj} \tag{15}$$

$$T_{c_b} = \tau_{c_b} \sum_{h\in\mathcal{H}} \sum_{j\in\mathcal{J}} \mu(h,j) c_{b,hj} \tag{16}$$

$$T_n = \tau_n w \sum_{h\in\mathcal{H}} \sum_{j\in\mathcal{J}_{\mathcal{W}}} \mu(h,j) \epsilon_j \tag{17}$$

$$A = \sum_{h\in\mathcal{H}} \sum_{j\in\mathcal{J}} (1-\varphi_{sj}) \mu(h,j) a_j \tag{18}$$

$$B = b \sum_{h\in\mathcal{H}} \sum_{j\in\mathcal{J}_{\mathcal{R}}} \mu(h,j) \tag{19}$$

$$M = \sum_{h\in\mathcal{H}} \sum_{j\in\mathcal{J}} \mu(h,j) m_{hj} \tag{20}$$

$$G = \varrho Y \tag{21}$$

where ϱ is the fixed share of government spending, G, in income. T_{c_g} and T_{c_b} are total taxes collected from good and bad consumption goods. T_n is total labor income tax collected from individuals. A is the wealth left by the deceased. B is total expenditures on social security benefits and M is the aggregate medical expenditures in the economy.

2.10 Equilibrium

A stationary competitive equilibrium of this economy for given insurance policy ω_w and ω_r; tax rates τ_{c_g}, τ_{c_b} and τ_n; social security replacement rate ρ; wage rate w; risk-free interest rate r; share of government expenditures ϱ is a set of decision rules, $\{I_{c_{bj}}(a_j, h_j, s_j)\}_{j=1}^J$, $\{c_{gj}(a_j, h_j, s_j)\}_{j=1}^J$, $\{c_{bj}(a_j, h_j, s_j)\}_{j=1}^J$, $\{m_j(a_j, h_j, s_j)\}_{j=1}^J$, $\{a_{j+1}(a_j, h_j, s_j)\}_{j=1}^J$; value functions $\{V_j(a_j, h_j, s_j)\}_{j=1}^J$; and measures of agent types $\mu(h,j)$ such that:

1. Given insurance policy ω_w and ω_r; tax rates τ_{c_g}, τ_{c_b} and τ_n; social security

replacement rate ρ; wage rate w; risk-free interest rate r, the decision rules and the value function solve the individual's dynamic problem.

2. τ_n clears the government budget in (14) given insurance policy ω_w and ω_r; tax rates τ_{c_g}, τ_{c_b} and τ_n; social security replacement rate ρ; and share of government expenditures ϱ.

3 Data and Calibration

3.1 Data

The model is calibrated using the Medical Expenditures Panel Survey (MEPS) dataset. I use longitudinal data from nine waves of the MEPS (Waves 6-14 from 2001 to 2010). For this study I include all households who are 20 or older.

Health capital variable used here is the Physical Component Summary (PCS) based on Short Form 12 Version 2 (SF-12v2) that asks individuals various questions about their physical and mental health. $h_1$and h_2 below are PCS scores for two consecutive years in each panel. Both h_1 and h_2 are normalized so that the values are between 0 and 1. Medical expenditures are deflated by the corresponding year's Consumer Price Index (CPI) for medical care (including medical goods and services), and total incomes of households are deflated by the CPI for all items, obtained from the Bureau of Labor Statistics.[7]

Depreciation rates of health capital is then estimated using the constructed health capital. Health production function is defined in equation (2). We observe from MEPS that households with high health capital spend much less on health compared to those with low health capital. The fact that medical expenditures are a function of health capital causes an endogeneity problem. To be able to cope with that, I estimate the following equations simultaneously using a three-stage least squares method developed by Zellner and Theil (1962). The estimation is performed for smokers and non-smokers separately.[8]

$$h_{2,i} = \beta_1 h_{1,i} + \beta_2 m_{1,i} + \sum_{j=1}^{J} \gamma_j D_{j,i} h_{1,i} + D_{shock,i} h_{1,i} + \epsilon_i \tag{22}$$

[7] Base year for CPI is 1982-84=100.

[8] Smokers are households who reported to be a smoker for two consecutive years in the panels and non-smokers are those who did not smoke in either of the two years.

$$m_{1,i} = \alpha_0 + \alpha_1 h_{1,i} + \alpha_2 Age_i + \alpha_3 Age_i^2 + \sum_{j=1}^{J} \theta_j D_{j,i} h_{1,i} + D_{shock,i} h_{1,i} + \nu_i \quad (23)$$

Subscripts 1 and 2 denote year 1 and year 2 as mentioned before. $D_{j,i}$ is a dummy variable that takes the value 1 if the individual i is at age j. $(1-\hat{\beta}_1-\hat{\gamma}_j D_{j,i})$ gives the estimate for $\delta_{h,j}$, age dependent depreciation rate for health. $D_{shock,i}$ is a dummy variable for health shock that takes the value 1 if a given individual's total medical expenditures exceed 40 percent of his/her income, and 0 otherwise. Estimation results are provided in the Appendix.

Nonlinear least squares using Gompertz function is then used to fit a smoothed curve to the estimated depreciation rates. Finally annual depreciation rates are converted to 5-year rates. While calculating the additional depreciation of health caused by a health shock, we assume that the shock hits once throughout a 5-year interval. Estimated and fitted depreciation rates can be found in the Appendix.

3.2 Calibration

Although the model is designed for any type of bad consumption, in the quantitative exercise I focus on smoking as the only bad consumption good. There are two sets of parameters in the model. The first set of parameters are picked from real data and literature and the second set of parameters are calibrated to match the relevant features of the U.S. data in the benchmark economy.

The period utility function is defined as:[9]

$$u(c_{gj}, c_{bj}, h_j) = u_0 + \frac{c_{gj}^{1-\sigma}}{1-\sigma} + \alpha \frac{h_j^{1-\gamma}}{1-\gamma} + \kappa c_{bj} \quad (24)$$

u_0 represents the value of being alive.[10] α and γ are quality of life parameters. κ is the weight on utility from bad consumption and σ is the coefficient of relative risk aversion for good consumption.

I start by by setting one model year to 5 years, where individuals start their life at age 20, retire at 65 and die with certainty at age 90, which coincides to $J = 14$ and $J_R = 10$ in the model. Wage rate, w, is normalized to 1 and interest rate, r, and the

[9]Hall and Jones (2007) and Özkan (2014) use this utility function too. Here bad consumption is added as an additional component.

[10]We need this so that the period utility is always positive, i.e., individuals get utility from an extra year of life.

time discount factor, β, are exogenously set to 2.5 percent and 0.98 respectively.[11] Efficiency profile for labor, ϵ_j, is obtained from Panel Study of Income Dynamics (PSID) data, following Rupert and Zanella (2014) and Abbasoğlu (2012).

The coefficient of relative risk aversion, σ, for good consumption is set to 2, as widely used in the literature.

Average sales tax rate in the U.S. is obtained from McDaniel (2007) and average excise tax rate on tobacco is obtained from Orzechowski and Walker (2011).[12] Hence τ_{cg} is taken as 7.42 percent and τ_{cb} is taken as 29.68 percent. Table 1 summarizes the fixed parameters of the model.

Table 1: Fixed Parameters

Parameter	Explanation	Value	Source
J	Life time	14	
J_R	Retirement age	10	
τ_{cg}	Sales tax rate	7.42%	McDaniel (2007)
τ_{cb}	Excise tax rate	29.68%	Orzechowski and Walker (2011)
β	Time discount factor	0.98 yearly	
w	Wage rate	1.2	
r	Interest rate	2.5% yearly	
σ	CRRA coefficient for c_g	2	
ρ	Replacement ratio	0.4	İmrohoroğlu et al. (1995)
u_0	Value of being alive	2.5	Özkan (2014)
α	Quality of life parameter	0.2	Özkan (2014)
γ	Quality of life parameter	1.15	Özkan (2014)

Using MEPS, annual probability of getting hit by a health shock conditional on past year's health shock realization is calculated. The resulting transition matrix is given by:

$$\Pi(s, s') = \begin{bmatrix} 0.474 & 0.526 \\ 0.082 & 0.918 \end{bmatrix} \tag{25}$$

Since the model period is 5 years, probability of getting hit by a health shock is set to its unconditional probability, i.e. $P(s_j = 1) = 0.1355$.

[11] Both 0.98 and 2.5 percent are annual rates.

[12] McDaniel (2007) calculated the tax rates for years 2000-2003. Both sales tax and excise tax rates are state averages, since sales taxes are imposed by states and excise taxes on cigarettes are a combination of federal and state taxes in the U.S.

Calibration of the rest of the parameters are performed in two steps. First I calibrate the parameters in the survival probability function, ψ and θ, to match the life expectancy of good health non-smokers and poor health smokers respectively.

Lew and Garfinkel (1987) use American Cancer Society Cancer Prevention Study I to estimate mortality by age, sex, health status and smoking habits. I use their estimates of life expectancy at age 35 of good health non-smokers and impaired health smokers, which are 44.96 and 33.62 respectively, to calibrate the parameters in the cumulative Weibull distribution that governs survival probability in the model. Recall that the survival probability is:

$$\varphi(h_j, \delta_{h,j}, s_j) = \left[1 - exp(-\psi \left[(1 - \delta_{h,j}) h_j \right]^{\theta}) \right] \tag{26}$$

Health capital variable obtained form MEPS is mapped into a finite set of possible health capital levels, $\mathcal{H}$. I take the minimum and maximum values of the constructed health capital and equally divide that interval into 20 grid points, with $h_{min} = 0.059898$ and $h_{max} = 1$. Assuming there are no health shocks, i.e. $s_j = 0$, we can define the probability of surviving to age $j+1$ for healthy non-smokers and unhealthy smokers by assuming $h = h_{min}$ for unhealthy $h = h_{max}$ for healthy. We also assume that non-smokers always face $\delta^{ns}_{h,j}$ and smokers always face $\delta^{s}_{h,j} = \delta^{ns}_{h,j} + \phi_j$. Thus we can denote the probabilities as follows:

$$p^{u,s}_j = 1 - exp(-\psi \left[(1 - \delta^{s}_{h,j}) h_{min} \right]^{\theta}) \tag{27}$$

$$p^{h,ns}_j = 1 - exp(-\psi \left[(1 - \delta^{ns}_{h,j}) h_{max} \right]^{\theta}) \tag{28}$$

where $p^{u,s}_j$ and $p^{h,ns}_j$ are the probabilities of surviving to age $j+1$ of an unhealthy smoker and health non-smoker respectively.

We use the methodology developed by Chiang (1968) to calculate life expectancy.[13] Suppose there are 19 age intervals, with interval start points x_i: $x_0 = 0$, $x_1 = 1$, $x_2 = 5$, $x_3 = 10$, ..., $x_{19} = 85$. n_i denotes interval width. For $i = 0$, $n_0 = 1$, for $i = 1$, $n_1 = 4$ and for $i \geq 2$, $n_i = 5$. p_i is the probability of surviving the interval i, which comes from the survival probability function in the model. Since the model starts at age 20, we set $p_i = 1$ for $i < 6$. $q_i = 1 - p_i$ is the probability of dying in interval i. l_i is the number of people alive at the start of interval. We start by

[13] Details about life expectancy calculations can be found in SEPHO (2005).

setting $l_0 = 100,000$ and then $l_i = p_{i-1}l_{i-1}$ for $i \geq 1$. Similarly $d_i = q_i l_i$ is the number of people dying in interval i. We define a_i as the average fraction of the interval that people survive before dying and set:

$$a_i = \begin{cases} 0.1 & \text{for} \quad i = 0 \\ 0.5 & \text{for} \quad i = 1, 2, ..., 19 \end{cases}$$

Deaths are evenly distributed for ages greater than 1, which is why $a_i = 0.5$ for $i \geq 1$. For under 1 though, deaths are more likely to occur in the perinatal and neonatal periods, which implies $a_0 = 0.1$. $L_i = n_i(l_i - d_i) + a_i n_i d_i$ gives the number of years lived in interval i. Finally $T_i = L_i + L_{i+1} + ... + L_{19}$ is the total number of years lived beyond the start of interval i. Using these we can calculate life expectancy at the start of interval i as the ratio of T_i to l_i:

$$e_i = \frac{T_i}{l_i}$$

Calibrating the model to match life expectancy of a healthy non-smoker and a unhealthy smoker at age 35, we get $\psi = 3.214$ and $\theta = 0.0857$.

I then choose the rest of the parameters to minimize the distance between model generated moments and target moments from the U.S. data. Let Ω be the vector of parameters to be calibrated:

$$\Omega = (\kappa, \nu, Z, \xi, \zeta) \tag{29}$$

I find Ω by minimizing the following objective function:

$$\min_{\Omega} \sum_{i=1}^{n_M} \Big(MM_i - TM_i \Big)^2 \tag{30}$$

where MM_i refers to model generated moments and TM_i refers to target moments from data. n_M denotes the number of calibrated parameters.

κ is chosen such that the percentage of smokers in the model matches its data counterpart from MEPS and ν is chosen to match the ratio of tobacco use in total consumption, which is obtained from NIPA accounts. Z and ξ are pinned down to match medical expenditure to GDP ratio for the total population and the workersulation in MEPS respectively. And finally, ζ is chosen to capture the medical expenditure differentials between healthy and unhealthy people from MEPS. Table 2 shows the calibrated parameters of the model and their relevant targets.

Table 2: Calibrated Parameters

Parameter	Explanation	Value	Target
ψ	Parameter in survival probability	3.1891	Life expectancy of never smokers vs. always smokers
θ	Parameter in survival probability	0.0702	Life expectancy of never smokers vs. always smokers
κ	Weight on c_b	0.5260	Share of smokers in the population
ν	Amount of c_b	0.1026	Share of tobacco consumption in total consumption
Z	Parameter on health production function	1.9021	Medical expenditures to GDP ratio
ξ	Parameter on health production function	0.7758	Medical expenditures to GDP ratio (for ages 20-64)
ζ	Parameter on health production function	1.9103	Ratio of medical expenditures of unhealthy to healthy

4 Results

Tax and coinsurance rates used in the benchmark calibration are given in Table 3. Coinsurance rate for the workers is set to 4.5 percent and the coinsurance rate for the retirees is set to 5 percent, both of which are estimated in Özkan (2014).[14] Labor income tax is chosen such that it clears the government budget. Initial distribution of agents over the health capital is the frequency of age 20-24 households in MEPS falling into the previously defined health capital grid points. Distribution of individuals in MEPS is given in Figure 1.

Table 4 displays results from the benchmark calibration. The model matches the data reasonably well. Notice that the total medical expenditures to GDP ratio is much smaller than what we would see in aggregate macro statistics, which is about 15 percent for the specified time period. I calculate this statistic from MEPS to be consistent with the medical expenditures over the life cycle. Ales et al. (2012) have a detailed discussion on the difference between the MEPS data and aggregate U.S. data where they document health expenditures to GDP ratios both from MEPS and

[14] I assume a very simple health care system in the model where there are no insurance premiums and deductibles. Instead, labor income tax is adjusted to balance the health care system. Thus, higher coverage is associated with higher taxes. One can think of this mechanism as a premium or coinsurance through taxes. In the U.S., depending on the coverage scheme, Medicare may involve premiums, deductibles and copayments depending on the duration and the provider of care. For example, under Medicare Part A, there is $0 cost for home and hospital care and there is no deductible, but one has to pay 20 percent of durable medical equipment. Also, hospital inpatient stays require some deductible depending on the duration of stay. Under Medicare Part B, there is a monthly premium which depends on the income of the individual.

NIPA tables. Life cycle profile of medical expenditures generated by the benchmark model is shown in Figure 2. The model can reproduce the life cycle pattern of medical expenditures to income ratio.

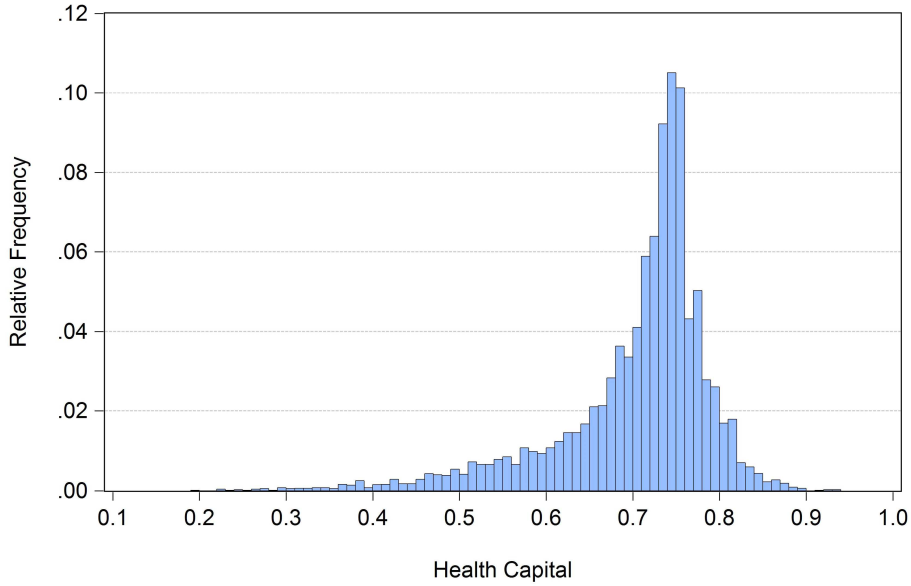

Figure 1: Distribution of health capital for individuals aged 20-24

Table 3: Tax and coinsurance rates in benchmark calibration

Parameter	Explanation	Value(%)	Source
τ_{c_g}	Sales tax on good consumption	7.42	McDaniel (2007)
τ_{c_b}	Excise tax on bad consumption	29.68	Orzechowski and Walker (2011)
ω_w	Coinsurance rate for workers	4.5	Estimated in Özkan (2014)
ω_r	Coinsurance rate for retired	5	Estimated in Özkan (2014)

Table 4: Model vs. Data

Target	Data	Model
Medical expenditure-output ratio	8.54%	8.53%
Medical expenditure-output ratio (20-64)	6.62%	5.58%
M(h=poor)/M(h=good)	3 - 10	5.28
Bad consumption-total consumption ratio	1.22%	1.35%
% of population that smokes	20.93%	20.60%

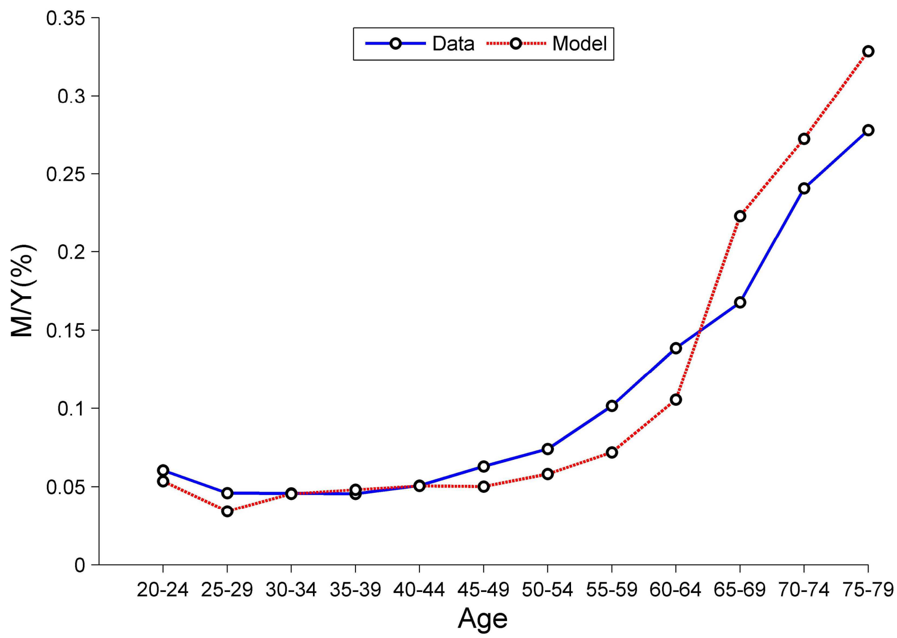

Figure 2: Medical Expenditure-Income Ratio by Age

4.1 Policy exercise: Effects of different coinsurance rates

I start by experimenting with various coinsurance rates for the workers and the retirees. For any coinsurance rate, government budget is cleared by adjusting the labor income tax rate. Hence, since the health system is financed through taxes, change in income tax can be thought of as a change in insurance premium too. Table 5 shows the results of these policy experiments for 10 different values of ω_w

and 3 different values of ω_r.

Increase in the coinsurance rate leads to a monotonic decline in medical expenditures to output ratio, M/Y, as well as the ratio of smokers. Going from a full insurance policy with $\omega_w = 0$ and $\omega_r = 0$ to a no insurance policy with $\omega_w = 1$ and $\omega_r = 1$, M/Y goes down by 1 percentage point while percentage of smokers decreases by more than 10 percentage points.

Table 5: Policy exercise with different coinsurance rates

ω_w	0%	4.5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
						($\omega_r = 5\%$)						
M/Y	8.58	8.53	8.29	8.26	8.23	8.19	8.15	8.06	8.01	7.87	7.81	7.74
M/Y (workers)	5.63	5.58	5.39	5.36	5.34	5.30	5.27	5.20	5.15	5.03	4.99	4.93
Ratio of c_b in c	1.44	1.35	1.02	1.01	1.01	0.99	0.97	0.93	0.89	0.63	0.61	0.50
% of smokers	21.86	20.60	15.83	15.55	15.48	15.17	14.86	14.43	13.73	9.76	9.49	7.76
Tax rate	7.56	7.24	5.59	5.16	4.82	4.36	3.93	2.97	2.35	1.40	0.67	0.09
						($\omega_r = 0\%$)						
M/Y	8.61	8.48	8.41	8.29	8.28	8.22	8.18	8.08	8.05	7.89	7.81	7.76
M/Y (workers)	5.65	5.53	5.46	5.38	5.36	5.32	5.29	5.21	5.17	5.05	4.98	4.94
Ratio of c_b in c	1.46	1.18	1.04	1.01	1.01	0.99	0.95	0.90	0.82	0.63	0.50	0.47
% of smokers	22.21	17.92	15.91	15.56	15.49	15.17	14.52	13.89	12.58	9.76	7.78	7.40
Tax rate	7.81	7.29	6.75	5.53	5.28	4.72	4.32	3.31	3.07	1.66	1.02	0.39
						($\omega_r = 20\%$)						
M/Y	8.41	8.38	8.33	8.19	7.99	7.96	7.92	7.89	7.86	7.81	7.73	7.62
M/Y (workers)	5.52	5.50	5.44	5.32	5.18	5.16	5.13	5.10	5.07	5.03	4.97	4.87
Ratio of c_b in c	1.48	1.45	1.33	1.03	0.99	0.98	0.97	0.95	0.93	0.89	0.80	0.62
% of smokers	22.79	22.29	20.52	15.87	15.51	15.44	15.18	14.85	14.51	13.88	12.58	9.76
Tax rate	5.69	5.46	5.14	4.35	2.23	1.83	1.41	0.99	0.56	0.01	-0.70	-1.73

Note: $\omega_w = 4.5\%$ is the benchmark.

To be able to see the change in smoking behavior of agents in the model according to their health status, we look at smoking prevalence by health capital. Table 6 provides shares of population that smoke for 5 different health levels. I divide the set $\mathcal{H}$ into 5 subsets with 4 health capital levels in each, i.e. $\mathcal{H}_1 = \{h^1, h^2, h^3, h^4\}$, $\mathcal{H}_2 = \{h^5, h^6, h^7, h^8\}$, $\mathcal{H}_3 = \{h^9, h^{10}, h^{11}, h^{12}\}$, $\mathcal{H}_4 = \{h^{13}, h^{14}, h^{15}, h^{16}\}$, $\mathcal{H}_5 = \{h^{17}, h^{18}, h^{19}, h^{20}\}$, and name them as poor, fair, good, very good and excellent health respectively. Poor health agents completely give up smoking for coinsurance rates 20 percent and above while fair health agents give up for 50 percent above. Although agents with other health levels do not completely give up smoking, reduction in smoking is larger for those with worse health levels since health maintenance is more costly for them.

Table 6: Change in smoking behavior by health capital

ω_w	0%	4.5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
						($\omega_r = 5\%$)						
Health Status												
Poor	16.51	16.43	15.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fair	21.77	15.16	15.18	14.78	10.05	4.22	0.00	0.00	0.00	0.00	0.00	0.00
Good	21.15	14.90	14.92	14.90	14.91	12.87	10.65	6.91	5.50	5.51	3.17	3.17
Very good	20.70	20.18	15.01	14.76	14.76	14.76	14.76	14.76	14.15	9.54	9.54	7.55
Excellent	20.64	20.70	15.66	14.71	14.69	14.66	14.74	14.71	14.63	14.67	14.70	14.64
						($\omega_r = 0\%$)						
Health Status												
Poor	22.59	15.27	14.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fair	18.89	15.10	15.08	14.65	10.03	4.17	0.00	0.00	0.00	0.00	0.00	0.00
Good	20.17	14.92	14.94	14.91	14.93	12.88	7.64	6.92	5.50	5.48	3.19	3.17
Very good	21.63	17.08	14.76	14.77	14.75	14.76	14.77	14.14	12.81	9.55	7.55	7.55
Excellent	15.61	20.62	20.64	14.72	14.71	14.69	14.68	14.67	14.68	14.72	14.71	8.57
						($\omega_r = 20\%$)						
Health Status												
Poor	11.52	12.00	6.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fair	21.31	15.13	15.11	13.52	11.69	6.13	4.24	0.00	0.00	0.00	0.00	0.00
Good	21.83	18.27	14.90	14.86	14.92	14.90	12.91	10.66	7.65	6.93	5.51	5.50
Very good	21.63	21.62	20.03	14.74	14.75	14.77	14.76	14.75	14.75	14.13	12.81	9.54
Excellent	21.58	21.56	21.51	20.71	14.89	14.72	14.71	14.69	14.69	14.64	14.62	14.70

4.1.1 Welfare Analysis

So far we have seen how changing the coinsurance rate affected smoking behavior as well as medical expenditures. But since smoking also generates utility, we need a welfare analysis to see which set of policies is the optimal one. To be able to do that, I calculate the total welfare under each coinsurance rate and the consumption compensation required to make agents in the benchmark economy as well off as agents under different health insurance policy regimes. I examine required consumption compensation for the whole economy as well as for each health capital separately. I start by defining the discounted life time utility of a newborn individual for policy χ as

$$W^{\chi} = \sum_{h=1}^{20}\sum_{j=1}^{15} \beta^{j-1}\mu(h,j)u\Big(c^{\chi}_{g,hj}, c^{\chi}_{b,hj}, h^{\chi}_{j}\Big) \tag{31}$$

$$W^{\chi}_{h} = \sum_{j=1}^{15} \beta^{j-1}u\Big(c^{\chi}_{g,hj}, c^{\chi}_{b,hj}, h^{\chi}_{j}\Big), \quad h = 1, 2, ..., 20 \tag{32}$$

So the consumption compensation, x, required for agents in the benchmark economy, denoted by χ^0, to make them as well off as under policy χ is calculated as:

$$\sum_{h=1}^{20}\sum_{j=1}^{15} \beta^{j-1}\mu(h,j)u\Big((1+x)c^{\chi^0}_{g,hj}, c^{\chi^0}_{b,hj}, h^{\chi^0}_{j}\Big) = \sum_{h=1}^{20}\sum_{j=1}^{15} \beta^{j-1}\mu(h,j)u\Big(c^{\chi}_{g,hj}, c^{\chi}_{b,hj}, h^{\chi}_{j}\Big) \tag{33}$$

$$\sum_{j=1}^{15} \beta^{j-1}u\Big((1+x_h)c^{\chi^0}_{g,hj}, c^{\chi^0}_{b,hj}, h^{\chi^0}_{j}\Big) = \sum_{j=1}^{15} \beta^{j-1}u\Big(c^{\chi}_{g,hj}, c^{\chi}_{b,hj}, h^{\chi}_{j}\Big), \quad h = 1, 2, ..., 20 \tag{34}$$

Tables 7, 8 and 9 display the x's calculated from the above equations compared to the benchmark economy. Since there are no households on the lowest 3 and top 1 health capital levels, I report welfare changes for $h^4 - h^{19}$ as well as for the aggregate. Positive numbers mean higher welfare whereas negative numbers mean lower welfare in those tables. As health insurance becomes less generous, healthy agents become better off while unhealthy agents become worse off. Healthy people would rather not contribute to a health insurance system where everyone pays the same premium because they incur less medical expenditures due to low health maintenance costs. Unhealthy people, on the other hand, would be unwilling to give up the health insurance since they would be spending much higher on health without the insurance.

Overall the largest welfare gain compared to the benchmark economy is when $\omega_w = 30\%$ and $\omega_r = 20\%$.[15] Under this set of policies, only the 2 least healthy agents incur welfare losses while all others have welfare gains.

[15] I disregard larger than 80 percent coinsurance rate for the workers when $\omega_r = 20\%$ since labor income tax turns negative in those cases.

Table 7: Welfare change with different coinsurance rates($\omega_r = 5\%$)

ω_w	0%	4.5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
health capital												
h^4	0.69	0.00	-1.06	-1.42	-3.11	-4.39	-6.56	-8.83	-8.80	-11.69	-11.55	-12.81
h^5	0.44	0.00	-0.80	-0.53	-1.96	-3.00	-4.20	-4.99	-5.98	-6.80	-7.83	-8.95
h^6	0.44	0.00	-0.57	-0.03	-1.20	-2.03	-2.93	-3.32	-3.96	-4.29	-5.00	-5.80
h^7	0.35	0.00	-0.31	0.32	-0.46	-1.40	-2.13	-2.32	-2.85	-3.07	-3.34	-4.13
h^8	0.28	0.00	0.06	0.57	-0.13	-0.55	-1.31	-1.33	-1.76	-1.81	-2.06	-2.39
h^9	0.23	0.00	0.12	0.96	0.24	-0.16	-0.53	-0.70	-0.94	-0.58	-0.74	-0.98
h^{10}	0.13	0.00	0.17	1.04	0.64	0.25	-0.19	-0.03	-0.15	0.02	0.00	-0.19
h^{11}	0.14	0.00	0.22	1.15	0.82	0.58	0.14	0.36	0.56	0.81	0.59	0.51
h^{12}	0.04	0.00	0.27	1.18	0.91	0.74	0.55	0.91	0.87	1.17	1.26	1.23
h^{13}	0.02	0.00	0.30	1.26	1.04	0.92	0.78	1.20	1.25	1.58	1.74	1.76
h^{14}	-0.06	0.00	0.32	1.26	1.08	1.00	0.91	1.38	1.46	1.86	2.06	2.11
h^{15}	-0.08	0.00	0.34	1.33	1.18	1.14	1.08	1.59	1.70	2.12	2.36	2.45
h^{16}	-0.09	0.00	0.37	1.38	1.26	1.25	1.23	1.76	1.92	2.36	2.71	2.75
h^{17}	-0.11	0.00	0.38	1.42	1.33	1.35	1.36	1.92	2.09	2.57	2.95	3.10
h^{18}	-0.12	0.00	0.39	1.46	1.40	1.44	1.54	2.04	2.24	2.74	3.35	3.33
h^{19}	-0.13	0.00	0.56	1.50	1.46	1.53	1.63	2.20	2.42	3.01	3.55	3.79
Aggregate	-0.05	0.00	0.32	1.30	1.11	1.04	0.94	1.40	1.50	1.89	2.11	2.15

Table 8: Welfare change with different coinsurance rates($\omega_r = 0\%$)

ω_w	0%	4.5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
health capital												
h^4	1.12	0.41	-0.25	-1.08	-3.24	-4.80	-6.70	-7.74	-10.58	-9.52	-11.02	-12.52
h^5	0.73	0.27	-0.14	-0.52	-2.04	-3.22	-4.30	-4.80	-6.71	-6.65	-7.56	-8.62
h^6	0.52	0.13	-0.10	0.18	-1.37	-1.78	-2.70	-3.04	-4.30	-4.33	-5.29	-5.82
h^7	0.18	0.40	0.25	0.34	-0.59	-1.38	-2.01	-2.14	-2.98	-2.85	-3.30	-3.87
h^8	0.29	0.34	0.31	0.52	-0.16	-0.67	-1.40	-1.42	-2.05	-1.81	-2.10	-2.40
h^9	0.19	0.30	0.34	0.72	0.08	-0.15	-0.68	-0.73	-1.37	-0.88	-1.08	-1.30
h^{10}	0.05	0.20	0.29	0.76	0.23	0.07	-0.26	-0.03	-0.84	-0.17	-0.04	-0.17
h^{11}	0.11	0.16	0.36	0.88	0.44	0.27	0.02	0.33	-0.12	0.75	0.53	0.47
h^{12}	-0.01	0.13	0.30	0.88	0.52	0.41	0.21	0.56	0.22	1.15	1.16	1.14
h^{13}	-0.03	0.14	0.37	0.94	0.64	0.59	0.40	0.82	0.53	1.50	1.58	1.65
h^{14}	-0.13	0.06	0.31	1.11	0.66	0.86	0.53	1.17	0.71	1.75	1.84	1.95
h^{15}	-0.16	0.05	0.31	1.15	0.92	0.98	0.89	1.45	1.10	2.06	2.18	2.35
h^{16}	-0.19	0.12	0.32	1.19	1.00	1.08	1.03	1.62	1.42	2.28	2.46	2.65
h^{17}	-0.28	0.10	0.38	1.22	1.05	1.17	1.14	1.76	1.59	2.48	2.68	2.91
h^{18}	-0.30	0.10	0.39	1.24	1.10	1.26	1.24	1.89	1.74	2.67	2.86	3.22
h^{19}	-0.32	0.09	0.38	1.28	1.16	1.36	1.37	2.00	1.84	2.83	3.07	3.42
Aggregate	-0.13	0.09	0.32	1.10	0.81	0.86	0.70	1.24	0.89	1.81	1.91	2.04

Table 9: Welfare change with different coinsurance rates($\omega_r = 20\%$)

ω_w	0%	4.5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
health capital												
h^4	0.90	0.28	-0.62	-2.07	-2.32	-4.46	-5.62	-7.72	-9.30	-10.95	-12.47	-13.36
h^5	1.12	0.61	-0.46	-0.91	-0.65	-2.28	-3.41	-4.73	-5.72	-7.60	-8.14	-8.37
h^6	1.05	0.56	0.14	-0.26	0.47	-0.73	-1.66	-2.59	-3.50	-4.22	-5.24	-5.54
h^7	1.09	0.67	0.38	-0.05	1.16	0.48	-0.70	-1.38	-2.05	-2.58	-3.16	-3.25
h^8	1.16	0.87	0.66	0.37	1.81	1.15	0.66	-0.32	-0.91	-1.31	-1.60	-1.24
h^9	1.26	1.02	0.86	0.77	2.31	1.79	1.34	0.64	0.22	-0.24	-0.13	0.00
h^{10}	1.32	1.06	1.01	1.01	2.60	2.21	1.80	1.47	0.91	1.00	0.73	0.95
h^{11}	1.36	1.14	1.13	1.21	2.86	2.57	2.28	1.96	1.71	1.63	1.62	1.92
h^{12}	1.34	1.28	1.16	1.31	3.02	2.78	2.57	2.35	2.11	2.20	2.16	2.52
h^{13}	1.39	1.35	1.21	1.46	3.21	3.04	2.87	2.71	2.57	2.48	2.76	3.16
h^{14}	1.35	1.33	1.22	1.50	3.29	3.17	3.04	2.94	2.82	2.85	3.09	3.54
h^{15}	1.38	1.38	1.42	1.60	3.43	3.34	3.25	3.18	3.12	3.17	3.36	3.94
h^{16}	1.40	1.41	1.48	1.68	3.57	3.49	3.45	3.40	3.37	3.45	3.67	4.19
h^{17}	1.42	1.45	1.52	1.90	3.67	3.62	3.61	3.58	3.59	3.70	3.95	4.50
h^{18}	1.44	1.48	1.57	1.92	3.83	3.78	3.81	3.82	3.80	3.95	4.24	4.78
h^{19}	1.46	1.50	1.62	1.98	3.98	3.94	3.92	3.99	3.97	4.09	4.47	5.05
Aggregate	1.38	1.35	1.35	1.54	3.34	3.21	3.10	2.98	2.88	2.91	3.08	3.57

4.2 Policy exercise: Effects of excise tax rates on bad consumption

Next I look at the effects of an increase in the excise tax on smoking, τ_{cb}. A major excise tax increase occurred in 2009 in the U.S., after which the national average of excise taxes on tobacco became about 42 percent.[16] Table 10 reports the results for the benchmark economy with $\tau_{cb} = 29$ and higher excise tax rates of 42 percent and 55 percent respectively.

Increase to 42 percent implies a 5 percentage point decline in the ratio of smokers and about 0.4 percentage point decline in M/Y. A further increase to 55 percent severely reduces the smoking prevalence to 7.6 percent while adding only 0.2 percentage point to the reduction in M/Y. Higher excise taxes are also welfare enhancing. Increase to 42 percent excise tax increases welfare that is equivalent to 1.46 percent more consumption.

[16] See Orzechowski and Walker (2011) for excise tax rates by states.

Table 10: Policy exercise with different tax rates on bad consumption

τ_{cb}	29%	42%	55%
M/Y	8.53	8.30	8.11
M/Y (workers)	5.58	5.39	5.20
Ratio of c_b in c	1.36	1.01	0.49
% of smokers	20.62	15.56	7.61
Tax rate	7.24	5.72	5.10
Change in Welfare		1.46	1.83

5 Conclusion

Risky health behaviors such as smoking are utility generating activities with external costs. The direct cost of those risky behaviors is higher medical expenditures due to increased health conditions. There are also indirect costs of risky health behaviors in an economy where health care expenditures are financed by taxes.

This paper develops a macroeconomic model of risky health behaviors to examine how policy affects those risky behaviors as well as medical expenditures in an equilibrium framework. An OLG model is calibrated to investigate different health insurance policies.

Results suggest that the optimal pair of coinsurance rates for the workers and the retirees are 30 percent and 20 percent respectively. Compared to the benchmark economy with 4.5 percent coinsurance rate for the worker and 5 percent coinsurance rate for the retired, the optimal policy leads to about half percentage point reduction in the medical expenditures to GDP ratio and 5 percentage points reduction in the percentage of smokers. In a health insurance system where everyone contributes the same amount regardless of their health capital, healthy people prefer less generous insurance policies whereas unhealthy people prefer more generous ones.

Results also suggest that the 2009 hike in excise taxes for tobacco generates a decline in the steady state ratio of smokers by about 5 percentage points coupled with a 0.2 percentage point decline in medical expenditures to GDP ratio.

The focus of the quantitative exercise in this paper is smoking. An interesting extension will be to add other risky health behaviours such as poor dietary activities and health generating activities such as physical exercise, both of which are important factors concerning obesity. I leave this subjects for future research.

References

Abbasoğlu, O. F. (2012). Life-cycle analysis with an increasing wage profile. Working Paper.

Ales, L., R. Hosseini, and L. E. Jones (2012, March). Is there "too much" inequality in health spending across income groups? Working Paper 17937, National Bureau of Economic Research.

Arrow, K. J. (1963). Uncertainty and the welfare economics of medical care. *The American Economic Review 53*(5), pp. 941–973.

Baicker, K., S. Mullainathan, and J. Schwartzstein (2013). Behavioral hazard in health insurance. Working Paper.

Barendregt, J. J., L. Bonneux, and P. J. van der Maas (1997). The health care costs of smoking. *The New England Journal of Medicine 337*, 1052–1057.

Blomqvist, Å. (1997). Optimal non-linear health insurance. *Journal of Health Economics 16*(3), 303 – 321.

Cawley, J. and C. Meyerhoefer (2011). The medical care costs of obesity: An instrumental variables approach. *Journal of Health Economics*.

Cawley, J. and C. J. Ruhm (2011). The economics of risky health behaviors. *Handbook of Health Economics Volume 2*, 95–199.

Chiang, C. (1968). The life table and its construction. In *Introduction to Stochastic Processes in Biostatistics*. New York: John Wiley & Sons.

Cole, H. L., S. Kim, and D. Krueger (2012, November). Analyzing the effects of insuring health risks: On the trade-off between short run insurance benefits vs. long run incentive costs. Working Paper 18572, National Bureau of Economic Research.

Cutler, D. M. and R. J. Zeckhauser (2000). The anatomy of health insurance. Volume 1, Part A of *Handbook of Health Economics*, pp. 563 – 643. Elsevier.

Danaei, G., E. L. Ding, D. Mozaffarian, B. Taylor, J. Rehm, C. J. L. Murray, and M. Ezzati (2009). The preventable causes of death in the United States: Comparative risk assessment of dietary, lifestyle, and metabolic risk factors. *PLoS Med 6*, e1000058.

De Nardi, M., E. French, and J. B. Jones (2010). Why do the elderly save? The role of medical expenses. *Journal of Political Economy 118*(1), 39–75.

Eggleston, K. (2000). Risk selection and optimal health insurance-provider payment systems. *Journal of Risk and Insurance 67(2)*, 173–196.

Feldman, R. and B. Dowd (1991). A new estimate of the welfare loss of excess health insurance. *The American Economic Review 81*(1), pp. 297–301.

Feldstein, M. and B. Friedman (1977). Tax subsidies, the rational demand for insurance and the health care crisis. *Journal of Public Economics 7*(2), 155 – 178.

Feng, Z. (2009). Macroeconomic consequences of alternative reforms to the health insurance system in the U.S. Working Paper.

Finkelstein, E. A., J. G. Trogdon, J. W. Cohen, and W. Dietz (2009). Annual medical spending attributable to obesity: Payer-and service-specific estimates. *Health Affairs 28*(2).

Grossman, M. (1972). On the concept of health capital and the demand for health. *Journal of Political Economy 80*(2), 223–255.

Hall, R. E. and C. I. Jones (2007). The value of life and the rise in health spending. *The Quarterly Journal of Economics 122*(1), 39–72.

Halliday, T. J., H. He, and H. Zhang (2011). Health investment over the life-cycle. Working Paper.

Hansen, G. D., M. Hsu, and J. Lee (2014). Health insurance reform: The impact of a medicare buy-in. *Journal of Economic Dynamics and Control 45*(0), 315 – 329.

He, H., K. X. Huang, and S.-T. Hung (2014). Are recessions good for your health? When Ruhm meets GHH. Working Paper.

İmrohoroğlu, A., S. İmrohoroğlu, and D. H. Joines (1995). A life cycle analysis of social security. *Economic Theory 6*, 83–114.

Jeske, K. and S. Kitao (2009). U.S. tax policy and health insurance demand: Can a regressive policy improve welfare? *Journal of Monetary Economics 56*, 210–221.

Jung, J. and C. Tran (2010). Market inefficiency, insurance mandate and welfare: U.S. health care reform 2010. Discussion Paper.

Lew, E. A. and L. Garfinkel (1987). Differences in mortality and longevity by sex, smoking habits and health status. *Transactions of Society of Actuaries 39*, 107–130.

Manning, W. G. and M. S. Marquis (1996). Health insurance: The tradeoff between risk pooling and moral hazard. *Journal of Health Economics 15*, 609–639.

McDaniel, C. (2007). Average tax rates on consumption, investment, labor and capital in the OECD 1950-2003. mimeo, Arizona State University.

McGinnis, J. M. and W. H. Foege (1993). Actual causes of death in the United States. *The Journal of the American Medical Association 270*(18), 2207–2212.

Miller, V. P., C. Ernst, and F. Collin (1999). Smoking-attributable medical care costs in the USA. *Socail Science & Medicine 48*, 375–391.

Mokdad, A. H., J. S. Marks, D. F. Stroup, and J. L. Gerberding (2005a). Actual causes of death in the United States, 2000. *The Journal of the American Medical Association 291*(10), 1238–1245.

Mokdad, A. H., J. S. Marks, D. F. Stroup, and J. L. Gerberding (2005b). Correction: Actual causes of death in the United States, 2000. *The Journal of the American Medical Association 293*(3), 293–294.

Newhouse, J. P. (1993). *Free for all?* Harvard University Press.

Orzechowski, W. and R. C. Walker (2011). The tax burden on tobacco.

Özkan, S. (2014). Preventive vs. curative medicine: A macroeconomic analysis of health care over the life cycle. Working Paper.

Palumbo, M. G. (1999). Uncertain medical expenses and precautionary saving near the end of the life cycle. *Review of Economics Studies 66*, 395–421.

Pashchenko, S. and P. Porapakkarm (2013). Quantitative analysis of health insurance reform: Separating regulation from redistribution. *Review of Economic Dynamics 16*(3), 383 – 404.

Peto, R., A. D. Lopez, J. Boreham, M. Thun, C. Heath, Jr., and R. Doll (1994). Mortality from smoking worldwide. *British Medical Bulletin 52*(1), 12–21.

Rice, D. P., T. A. Hodgson, P. Sinsheimer, W. Browner, and A. N. Kopstein (1986). The economic costs of the health effects of smoking, 1984. *The Milbank Quarterly 64*(4), 489–547.

Rupert, P. and G. Zanella (2014). Revisiting wage, earnings, and hours profiles. *Journal of Monetary Economics, forthcoming*.

Scholz, J. K. and A. Seshadri (2010). Health and wealth in a life-cycle model. Working Paper.

SEPHO (2005, November). Calculating life expectancy in small areas. Technical report, South East Public Health Observatory.

Sloan, F. A., J. Ostermann, C. Conover, D. H. Taylor, Jr., and G. Picone (2004). *The Price of Smoking*. The MIT Press.

Stewart, S. T., D. M. Cutler, and A. B. Rosen (2009). Forecasting the effects of obesity and smoking on U.S. life expectancy. *The New England Journal of Medicine 361*, 2252–2260.

Warner, K. E., T. A. Hodgson, and C. E. Carroll (1999). Medical costs of smoking in the United States: estimates, their validity, and their implications. *Tobacco Control 8*, 290–300.

Woloshin, S., L. M. Schwartz, and H. G. Welch (2008). The risk of death by age, sex, and smoking status in the United States: Putting health risks in context. *Journal of the National Cancer Institute 100*(12), 845–853.

Xu, K., D. B. Evans, K. Kawabata, R. Zeramdini, J. Klavus, and C. J. L. Murray (2003). Household catastrophic health expenditure: A multicountry analysis. *Lancet 362*, 111–117.

Zeckhauser, R. (1970). Medical insurance: A case study of the tradeoff between risk spreading and appropriate incentives. *Journal of Economic Theory 2*(1), 10 – 26.

Zellner, A. and H. Theil (1962). Three-stage least squares: Simultaneous estimation of simultaneous equations. *Econometrica 30*(1), pp. 54–78.

Zweifel, P. and W. G. Manning (2000). Moral hazard and consumer incentives in health care. *Handbook of Development Economics Volume 1*, 409–459.

Appendices

A Additional Tables and Figures

Table A1: Estimation Results

	NON-SMOKERS		SMOKERS	
VARIABLES	h_2	m_1	h_2	m_1
Constant		11,441***		8,218***
		(415.0)		(716.6)
h_1	0.999***	-17,880***	1.037***	-12,271***
	(0.0488)	(1,201)	(0.0913)	(1,861)
Age		-197.2***		-162.1***
		(15.53)		(28.92)
Age^2		1.380***		1.343***
		(0.138)		(0.283)
m_1	3.60e-05***		4.47e-05***	
	(7.06e-07)		(1.90e-06)	
D_{shock}*h_1	-0.275***	6,529***	-0.362***	6,920***
	(0.00667)	(80.67)	(0.0175)	(140.2)
D_{17}*h_1	0.0223	5,516***	0.00709	2,953*
	(0.0511)	(1,121)	(0.101)	(1,766)
D_{18}*h_1	0.0107	5,955***	-0.0291	3,923**
	(0.0496)	(1,099)	(0.0944)	(1,691)
D_{19}*h_1	0.0114	6,452***	-0.0259	4,040**
	(0.0497)	(1,106)	(0.0940)	(1,694)
D_{20}*h_1	-0.00945	6,787***	-0.0539	4,573***
	(0.0498)	(1,113)	(0.0935)	(1,700)
D_{21}*h_1	-0.00124	7,026***	-0.0407	4,702***
	(0.0497)	(1,117)	(0.0935)	(1,711)
D_{22}*h_1	-0.00647	7,370***	-0.0412	4,854***
	(0.0496)	(1,121)	(0.0929)	(1,715)
D_{23}*h_1	-0.0138	7,743***	-0.0501	4,992***
	(0.0496)	(1,127)	(0.0931)	(1,729)
D_{24}*h_1	-0.0250	7,874***	-0.0569	5,538***
	(0.0496)	(1,132)	(0.0930)	(1,740)
D_{25}*h_1	-0.0235	8,263***	-0.0857	5,577***
	(0.0496)	(1,137)	(0.0930)	(1,748)
D_{26}*h_1	-0.0308	8,428***	-0.0605	5,531***
	(0.0495)	(1,142)	(0.0930)	(1,760)
D_{27}*h_1	-0.0305	8,628***	-0.0765	5,775***
	(0.0495)	(1,146)	(0.0932)	(1,772)

(continued. . .)

Table A1: Estimation Results

	NON-SMOKERS		SMOKERS	
VARIABLES	h_2	m_1	h_2	m_1
D_{28}*h_1	-0.0235	8,788***	-0.0787	5,857***
	(0.0495)	(1,151)	(0.0931)	(1,783)
D_{29}*h_1	-0.0305	8,920***	-0.0600	6,071***
	(0.0494)	(1,156)	(0.0931)	(1,793)
D_{30}*h_1	-0.0339	9,155***	-0.0632	6,167***
	(0.0494)	(1,161)	(0.0929)	(1,802)
D_{31}*h_1	-0.0385	9,452***	-0.0983	6,494***
	(0.0494)	(1,165)	(0.0931)	(1,812)
D_{32}*h_1	-0.0354	9,511***	-0.0785	6,666***
	(0.0495)	(1,171)	(0.0928)	(1,819)
D_{33}*h_1	-0.0380	9,652***	-0.0866	6,761***
	(0.0494)	(1,175)	(0.0930)	(1,830)
D_{34}*h_1	-0.0357	9,780***	-0.0900	6,654***
	(0.0494)	(1,179)	(0.0929)	(1,838)
D_{35}*h_1	-0.0403	9,947***	-0.0982	7,065***
	(0.0494)	(1,184)	(0.0930)	(1,846)
D_{36}*h_1	-0.0432	10,171***	-0.0948	7,023***
	(0.0494)	(1,188)	(0.0930)	(1,856)
D_{37}*h_1	-0.0399	10,161***	-0.118	7,211***
	(0.0493)	(1,192)	(0.0929)	(1,861)
D_{38}*h_1	-0.0327	10,165***	-0.104	7,558***
	(0.0494)	(1,197)	(0.0929)	(1,869)
D_{39}*h_1	-0.0305	10,261***	-0.110	7,805***
	(0.0493)	(1,199)	(0.0927)	(1,874)
D_{40}*h_1	-0.0388	10,540***	-0.115	7,846***
	(0.0493)	(1,203)	(0.0929)	(1,883)
D_{41}*h_1	-0.0446	10,705***	-0.0918	7,374***
	(0.0494)	(1,207)	(0.0927)	(1,887)
D_{42}*h_1	-0.0385	10,842***	-0.107	7,668***
	(0.0494)	(1,211)	(0.0925)	(1,891)
D_{43}*h_1	-0.0494	10,898***	-0.0999	7,628***
	(0.0493)	(1,214)	(0.0926)	(1,897)
D_{44}*h_1	-0.0352	10,893***	-0.112	7,854***
	(0.0494)	(1,217)	(0.0925)	(1,901)
D_{45}*h_1	-0.0535	11,290***	-0.108	8,037***
	(0.0493)	(1,220)	(0.0926)	(1,907)
D_{46}*h_1	-0.0490	11,337***	-0.0909	7,746***
	(0.0493)	(1,223)	(0.0927)	(1,914)
D_{47}*h_1	-0.0572	11,501***	-0.112	8,155***
	(0.0494)	(1,226)	(0.0925)	(1,914)
D_{48}*h_1	-0.0573	11,466***	-0.107	8,033***

(continued. . .)

Table A1: Estimation Results

	NON-SMOKERS		SMOKERS	
VARIABLES	h_2	m_1	h_2	m_1
	(0.0493)	(1,228)	(0.0925)	(1,918)
D_{49}*h_1	-0.0474	11,583***	-0.107	8,129***
	(0.0494)	(1,231)	(0.0926)	(1,923)
D_{50}*h_1	-0.0592	11,840***	-0.141	8,180***
	(0.0494)	(1,233)	(0.0929)	(1,930)
D_{51}*h_1	-0.0686	12,028***	-0.0974	7,994***
	(0.0494)	(1,235)	(0.0927)	(1,929)
D_{52}*h_1	-0.0613	11,973***	-0.117	8,151***
	(0.0494)	(1,237)	(0.0928)	(1,931)
D_{53}*h_1	-0.0767	12,157***	-0.150	8,660***
	(0.0494)	(1,239)	(0.0928)	(1,932)
D_{54}*h_1	-0.0731	12,355***	-0.147	9,032***
	(0.0494)	(1,239)	(0.0933)	(1,939)
D_{55}*h_1	-0.0738	12,458***	-0.132	9,016***
	(0.0494)	(1,241)	(0.0930)	(1,934)
D_{56}*h_1	-0.0866*	12,608***	-0.131	8,465***
	(0.0494)	(1,242)	(0.0934)	(1,939)
D_{57}*h_1	-0.0901*	12,613***	-0.152	8,830***
	(0.0495)	(1,245)	(0.0938)	(1,942)
D_{58}*h_1	-0.0953*	12,841***	-0.131	8,787***
	(0.0495)	(1,245)	(0.0935)	(1,938)
D_{59}*h_1	-0.0760	12,539***	-0.124	8,355***
	(0.0496)	(1,247)	(0.0941)	(1,946)
D_{60}*h_1	-0.0850*	12,975***	-0.169*	8,879***
	(0.0496)	(1,247)	(0.0942)	(1,944)
D_{61}*h_1	-0.0804	12,724***	-0.200**	9,305***
	(0.0496)	(1,247)	(0.0941)	(1,938)
D_{62}*h_1	-0.0826*	12,662***	-0.122	8,088***
	(0.0497)	(1,249)	(0.0948)	(1,943)
D_{63}*h_1	-0.0937*	12,920***	-0.173*	8,966***
	(0.0498)	(1,249)	(0.0943)	(1,933)
D_{64}*h_1	-0.101**	13,012***	-0.148	8,877***
	(0.0497)	(1,247)	(0.0947)	(1,933)
D_{65}*h_1	-0.0939*	12,853***	-0.129	8,068***
	(0.0498)	(1,247)	(0.0951)	(1,937)
D_{66}*h_1	-0.105**	12,920***	-0.160*	8,559***
	(0.0499)	(1,247)	(0.0963)	(1,946)
D_{67}*h_1	-0.107**	13,172***	-0.160*	8,442***
	(0.0499)	(1,246)	(0.0965)	(1,944)
D_{68}*h_1	-0.0940*	12,766***	-0.108	7,651***
	(0.0500)	(1,246)	(0.0965)	(1,937)

(continued…)

Table A1: Estimation Results

	NON-SMOKERS		SMOKERS	
VARIABLES	h_2	m_1	h_2	m_1
D_{69}*h_1	-0.0787	12,639***	-0.219**	9,914***
	(0.0500)	(1,245)	(0.0987)	(1,959)
D_{70}*h_1	-0.107**	13,257***	-0.150	8,420***
	(0.0501)	(1,245)	(0.0977)	(1,941)
D_{71}*h_1	-0.122**	13,347***	-0.180*	8,536***
	(0.0500)	(1,240)	(0.0975)	(1,932)
D_{72}*h_1	-0.104**	13,296***	-0.141	7,941***
	(0.0502)	(1,241)	(0.0976)	(1,926)
D_{73}*h_1	-0.128**	12,982***	-0.200**	8,585***
	(0.0501)	(1,236)	(0.100)	(1,954)
D_{74}*h_1	-0.137***	13,456***	-0.227**	9,081***
	(0.0501)	(1,233)	(0.101)	(1,962)
D_{75}*h_1	-0.130***	13,214***	-0.201**	7,742***
	(0.0503)	(1,234)	(0.101)	(1,954)
D_{76}*h_1	-0.141***	12,997***	-0.223**	8,419***
	(0.0503)	(1,231)	(0.103)	(1,975)
D_{77}*h_1	-0.117**	12,722***	-0.126	7,111***
	(0.0505)	(1,230)	(0.106)	(2,002)
D_{78}*h_1	-0.119**	13,021***	-0.0255	6,989***
	(0.0507)	(1,232)	(0.109)	(2,032)
D_{79}*h_1	-0.151***	13,395***	-0.311***	9,789***
	(0.0508)	(1,229)	(0.110)	(2,042)
D_{80}*h_1	-0.154***	12,793***	-0.210*	8,051***
	(0.0514)	(1,236)	(0.111)	(2,044)
D_{81}*h_1	-0.155***	12,624***	-0.223**	6,784***
	(0.0512)	(1,227)	(0.108)	(2,002)
D_{82}*h_1	-0.138***	12,289***	-0.292**	8,844***
	(0.0514)	(1,228)	(0.120)	(2,157)
D_{83}*h_1	-0.152***	12,658***	-0.323**	10,589***
	(0.0517)	(1,228)	(0.155)	(2,677)
D_{84}*h_1	-0.127**	11,727***	-0.197	9,302***
	(0.0525)	(1,239)	(0.131)	(2,314)
D_{85}*h_1	-0.182***	12,607***	-0.321***	8,263***
	(0.0499)	(1,188)	(0.108)	(1,980)
Observations	45,004	45,004	9,247	9,247
R-squared	0.948	0.211	0.940	0.290

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A2: Health Depreciation Rates by Age

	Smoker		Non-smoker			Smoker		Non-smoker	
Age	Actual	Fitted	Actual	Fitted	Age	Actual	Fitted	Actual	Fitted
20	0.0169	0.0301	0.0105	0.0178	53	0.1130	0.0848	0.0777	0.0688
21	0.0037	0.0311	0.0022	0.0187	54	0.1100	0.0874	0.0741	0.0711
22	0.0042	0.0321	0.0075	0.0197	55	0.0950	0.0901	0.0748	0.0734
23	0.0131	0.0331	0.0148	0.0207	56	0.0940	0.0929	0.0876	0.0757
24	0.0199	0.0342	0.0260	0.0217	57	0.1150	0.0957	0.0911	0.0781
25	0.0487	0.0353	0.0245	0.0227	58	0.0940	0.0987	0.0963	0.0805
26	0.0235	0.0365	0.0318	0.0238	59	0.0870	0.1017	0.0770	0.0829
27	0.0395	0.0377	0.0315	0.0250	60	0.1320	0.1048	0.0860	0.0854
28	0.0417	0.0389	0.0245	0.0262	61	0.1630	0.1080	0.0814	0.0880
29	0.0230	0.0401	0.0315	0.0274	62	0.0850	0.1113	0.0836	0.0905
30	0.0262	0.0414	0.0349	0.0286	63	0.1360	0.1147	0.0947	0.0931
31	0.0613	0.0428	0.0395	0.0299	64	0.1110	0.1182	0.1020	0.0958
32	0.0415	0.0442	0.0364	0.0313	65	0.0920	0.1217	0.0949	0.0985
33	0.0496	0.0456	0.0390	0.0326	66	0.1230	0.1254	0.1060	0.1012
34	0.0530	0.0470	0.0367	0.0341	67	0.1230	0.1292	0.1080	0.1039
35	0.0612	0.0485	0.0413	0.0355	68	0.0710	0.1331	0.0950	0.1067
36	0.0578	0.0501	0.0442	0.0370	69	0.1820	0.1371	0.0797	0.1096
37	0.0810	0.0517	0.0409	0.0385	70	0.1130	0.1412	0.1080	0.1124
38	0.0670	0.0533	0.0337	0.0401	71	0.1430	0.1454	0.1230	0.1153
39	0.0730	0.0550	0.0315	0.0417	72	0.1040	0.1498	0.1050	0.1183
40	0.0780	0.0568	0.0398	0.0434	73	0.1630	0.1542	0.1290	0.1212
41	0.0548	0.0586	0.0456	0.0451	74	0.1900	0.1588	0.1380	0.1242
42	0.0700	0.0604	0.0395	0.0468	75	0.1640	0.1635	0.1310	0.1272
43	0.0629	0.0623	0.0504	0.0486	76	0.1860	0.1684	0.1420	0.1303
44	0.0750	0.0643	0.0362	0.0505	77	0.0890	0.1734	0.1180	0.1334
45	0.0710	0.0663	0.0545	0.0523	78	-0.0115	0.1785	0.1200	0.1365
46	0.0539	0.0684	0.0500	0.0542	79	0.2740	0.1838	0.1520	0.1397
47	0.0750	0.0706	0.0582	0.0562	80	0.1730	0.1892	0.1550	0.1428
48	0.0700	0.0728	0.0583	0.0582	81	0.1860	0.1948	0.1560	0.1460
49	0.0700	0.0750	0.0484	0.0602	82	0.2550	0.2005	0.1390	0.1493
50	0.1040	0.0774	0.0602	0.0623	83	0.2860	0.2063	0.1530	0.1525
51	0.0604	0.0798	0.0696	0.0644	84	0.1600	0.2124	0.1280	0.1558
52	0.0800	0.0822	0.0623	0.0666	85	0.2840	0.2186	0.1830	0.1591

Table A3: Health Depreciation Rates by Age Interval

Age	Non-smoker	Smoker	Difference(ϕ)
20-24	0.0947	0.1506	0.0559
25-29	0.1190	0.1748	0.0558
30-34	0.1470	0.2023	0.0553
35-39	0.1786	0.2333	0.0547
40-44	0.2135	0.2680	0.0546
45-49	0.2513	0.3066	0.0553
50-54	0.2917	0.3492	0.0575
55-59	0.3341	0.3957	0.0616
60-64	0.3779	0.4460	0.0680
65-69	0.4225	0.4996	0.0771
70-74	0.4672	0.5561	0.0889
75-79	0.5113	0.6145	0.1031
80-84	0.5545	0.6737	0.1192

Table A4: Additional depreciation if health shock hits

Age	Non-smoker	Smoker
20-24	0.2539	0.3177
25-29	0.2485	0.3104
30-34	0.2422	0.3021
35-39	0.2349	0.2927
40-44	0.2269	0.2821
45-49	0.2182	0.2701
50-54	0.2087	0.2567
55-59	0.1987	0.2419
60-64	0.1881	0.2257
65-69	0.1772	0.2081
70-74	0.1662	0.1890
75-79	0.1551	0.1688
80-84	0.1440	0.1478

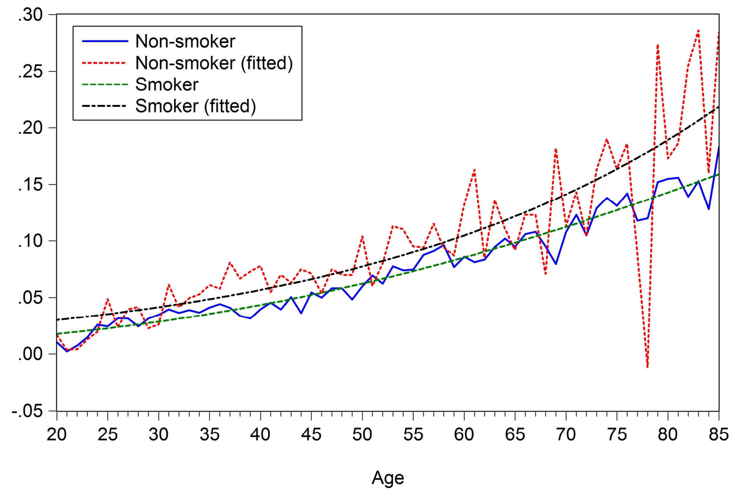

Figure A1: Health Depreciation by Age

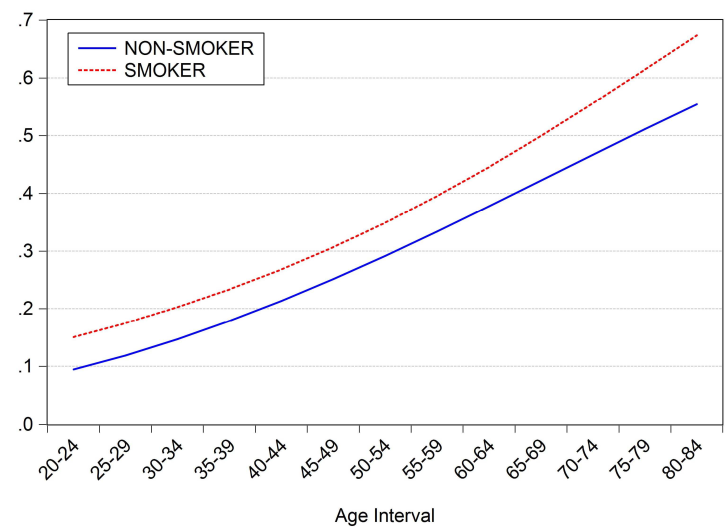

Figure A2: Health Depreciation by 5-Year Age Intervals

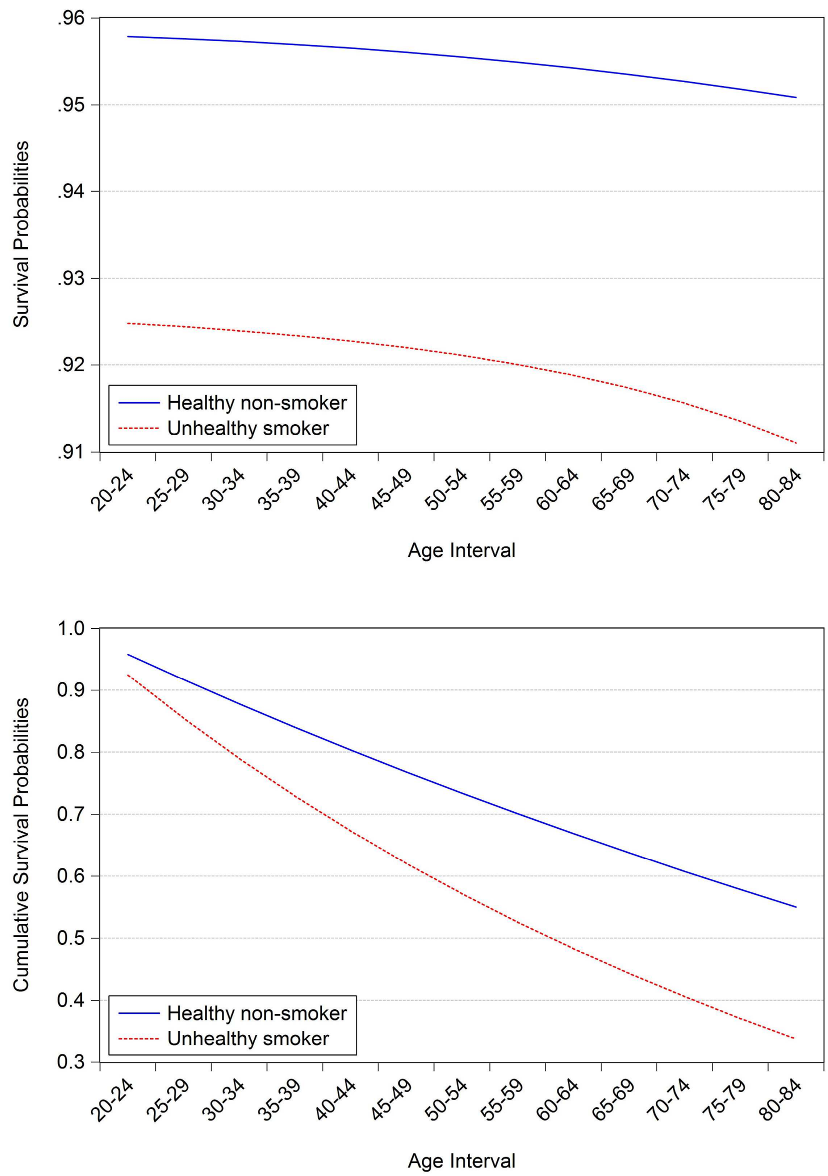

Figure A3: Survival Probabilities by Age

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