CREDIT, DEFAULT, AND OPTIMAL HEALTH INSURANCE

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Abstract

How do credit and default affect optimal health insurance? I answer this question, using a life-cycle model of health investment with a strategic default option on emergency room (ER) bills and financial debts. I calibrate the model to the U.S. economy and compare the optimal policy for Medicaid according to whether the strategic default option and access to credit are available. I find that the strategic default option induces the optimal policy to be more redistributive. With the strategic default option, the optimal policy expands Medicaid for households whose income is below 44 percent of the average income. Without the strategic default option, the optimal policy provides Medicaid to households whose income is below 25 percent of the average income. Through the strategic default option, more redistributive reforms can improve welfare by reducing the dependence on this implicit health insurance and changing young and low-income households' medical spending behaviors to be more preventative. In these findings, the interaction between strategic default and preventative medical spending is important. When the preventative medical spending channel is shut down, the optimal policy in the case with the strategic default option is not to expand Medicaid.

JEL classification: E21, H51, I13, K35.

Keywords: Credit, Default, Bankruptcy, Optimal Health Insurance

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1 Introduction

A growing body of empirical studies has recently investigated the interactions between health-related events and household finance. Many studies have found that healthcare reforms and adverse health-related events affect households' financial outcomes, such as bankruptcies, delinquencies, credit scores, and unpaid debts (Gross and Notowidigdo, 2011; Mazumder and Miller, 2016; Hu et al., 2018; Miller et al., 2018; Dobkin et al., 2018; Deshpande et al., 2019). Mahoney (2015), in the opposite direction, shows that bankruptcies and emergency rooms (ERs) act as types of implicit health insurance because households with lower bankruptcy costs are reluctant to buy health insurance by relying on these institutional features. These empirical findings have been widely used to support the expansion of health insurance coverage against financial shocks from health issues. However, relatively few structural approaches exist that examine how credit and default affect the design of optimal health insurance policies given the difficulty in devising a framework that incorporates complex features of institutions for both bankruptcy and health insurance, entailing multiple trade-offs in welfare changes. In this paper, I fill this void by using a rich general equilibrium model to characterize the optimal health insurance policy according to whether access to credit and a strategic default option are available.

To examine the effect of these financial channels on optimal health insurance policy, understanding how households' health-related risk-sharing decisions interact with these financial channels is a prerequisite. Although an expansion of public health insurance, for example, indicates the same change in the policy rule regardless of default structure, changes in the magnitude of insurance during those health shocks faced by households can differ according to the availability of strategic default. When the cost of defaulting is so extreme that households do not default voluntarily—the lack of a strategic default option—the expansion of public health insurance provides more insurance channels. Moreover, this strategic default option can lead households to exhibit different medical spending behaviors, possibly due to the extent of their preventative motives for healthcare differing according to default costs. Finally, the strategic default option can affect households' health insurance demand by making them rely more on default as implicit health insurance. These differences in households' behaviors are quantitative in nature, thereby leading to disparities in the extent to which optimal policies are redistributive. Therefore, the above channels must be quantitatively investigated before optimal health insurance policies are characterized.

I undertake this quantitative analysis by building a model on the consumer bankruptcy framework used in Chatterjee, Corbae, Nakajima and Ríos-Rull (2007); Livshits, MacGee and Tertilt (2007) and the health capital framework of Grossman (1972, 2000, 2017). Asset markets are incomplete, and households have the option to default on their medical bills and financial debts. If a debtor defaults on his debt, the debt is eliminated, but his credit history is damaged. This default is recorded in his credit history, which hinders his borrowing in the future. The loan price differs across individual states because it is determined by individual expected default probabilities. In the spirit of Grossman (1972, 2000, 2017), health capital is a component of individual utility and affects labor productivity and the mortality rate. Moreover, health shocks depreciate the stock of health capital, resulting in reduced utility, labor productivity, and survival probability.

This model extends the standard health capital model in two directions. First, the model considers two types of health shocks: emergency and non-emergency. This setting is chosen to reflect the institutional features of the Emergency Medical Treatment and Labor Act (EMTALA), which is an important channel for defaults on medical bills, as Mahoney (2015) and Dobkin, Finkelstein, Kluender and Notowidigdo (2018) note in their empirical analyses.[1] Second, motivated by the study of Galama and Kapteyn (2011) and Ozkan (2017), health capital determines not the level of health but the distributions of these health shocks. This setting helps address a well-known criticism of the model of Grossman (1972). The model of Grossman (1972) predicts that the demand for medical services is positively related to health status, but these factors are negatively related in the actual data. With this setting, the model generates a negative relationship between the demand for medical services and health status because households who accumulate a higher level of health capital stock have a lower probability of emergency medical events and severe medical conditions. This setup additionally enables me to capture the additional preventative medical treatment effects of health insurance policies.

Using micro and macro data, I calibrate the model to the U.S. economy before the Affordable Care Act (ACA). This model performs well in matching life-cycle and cross-sectional moments on income, health insurance, medical expenditures, medical conditions, and ER visits. The model accounts for salient life-cycle and cross-sectional dimensions of health insurance and health inequality. Furthermore, the model reproduces the untargeted interrelationships among income, medical conditions, and ER visits.[2] These strong performances are largely achieved by the extended health capital framework. The model is also good at capturing the important life-cycle and cross-sectional dimensions of credit and bankruptcy.

In the first set of exercises, I use the calibrated model to investigate the effect of credit and the strategic default option on the economy under the baseline health insurance system. To do so, I compare three economies: "Benchmark", "Costly Default", and "No Borrowing". I refer to the economy with the strategic default option as "Benchmark". I set up "Costly Default" by imposing

[1] In the U.S., hospitals can assess the financial status of non-emergency patients before providing non-emergency medical treatment, but they cannot take this financial screening step before providing emergency medical treatment due to regulations in the EMTALA. Prior to the implementation of the EMTALA, "patient dumping", referring to refusing ER treatment due to patients' lack of insurance and ability to pay, was allowed.

[2] Using data from the Medical Expenditure Panel Survey (MEPS), I find that the levels of health risks vary across income groups. Low-income households tend to have more severe medical conditions and to visit emergency rooms more frequently over the life-cycle.Appendix B describes the details of these empirical findings.

an extreme penalty of defaulting that prevents strategic defaults. Thus, comparing "Benchmark" with "Costly Default" allows me to examine the effects of the strategic default option on the economy. However, turning off the strategic default option involves more accessible credit—lower borrowing costs—as a byproduct. To isolate this additional mechanism, I turn off the borrowing channel under "Costly Default" and refer to this economy as "No Borrowing"; therefore, comparing "Costly Default" with "No Borrowing" shows how the availability of increased access to credit affects the economy.

Through these comparisons, I find that the absence of the strategic default option induces additional precautionary motives against health risks, leading working-age households to increase their savings, purchase of private individual health insurance, and medical spending. When available, households can use the strategic default option as implicit health insurance because they can rely on it to insure against financial and health risks. In contrast, in the economy without the strategic default option, households are more cautious in managing their health and spend on healthcare to be more preventative because poor health would otherwise come at a substantial financial burden over the life-cycle. These additional precautionary motives against health risks cause households to increase their spending on healthcare services, demand for private health insurance, and asset accumulation during the working-age period.

In these results, preventative motives for healthcare are crucial. I check the importance of preventive healthcare in explaining these differences in households' medical spending behavior and health insurance demand by isolating the effects of health capital on the distribution of health shocks. When this preventative medical spending channel is shut down—the exogenous distribution of health shocks—young households in the economies without the strategic default option do not show such increases in medical spending. Therefore, when the distribution of health shocks is endogenous, young households increase their medical spending for the preemptive management of the evolution of health risks; otherwise, these health risks can trigger defaults, the costs of which are extreme without the strategic default option. These findings imply that this risk management channel causes young households in the economy without the strategic default to spend more on health than those in the economy with strategic default.

These preventative motives for medical spending also play critical roles in the differences in households' health insurance demand according to the availability of the strategic default option. I find that the motives for demanding health insurance can substantially differ because of the interaction between strategic default and preventative medical spending. I turn off the preventative medical spending channel by setting the distribution of health shocks to be exogenous, and examine how health insurance demand changes across the three economies. While the cases without the strategic default option—"Costly Default" and "No Borrowing"—generate non-significant changes in health insurance demand, the benchmark economy shows a substantial reduction (10-20 percentage points) in private health insurance demand, particularly for young households. These findings suggest that whereas health insurance demand aims primarily to avoid catastrophic costs due to default in those without the strategic default option, preventative medical spending motives drive a substantial portion of health insurance demand in the benchmark case.

In the second set of experiments, considering the significant impacts of strategic default on households' health-related decisions, I investigate how different the optimal Medicaid expansion is for each of the three economies. I find that the strategic default option induces the optimal health insurance policy to be more redistributive. The optimal income threshold for Medicaid eligibility with the strategic default option ("Benchmark") is 44 percent of the average income. Without the option ("Costly Default"), the optimal income threshold is 25 percent of the average income. Meanwhile, more accessible credit, involved by turning off the strategic default option, has little role in determining the extent to which the optimal policy is redistributive; the optimal income threshold for Medicaid eligibility under "No Borrowing" is the same as that under "Costly Default".

To understand where these differences originate, I examine changes in consumption and health—the inputs of the utility function—when adjusting the income threshold for Medicaid eligibility from 25 percent—the optimal under "Costly Default" and "No Borrowing"—to 44 percent of the average income—the optimal under "Benchmark". The economy with the strategic default option ("Benchmark") has more substantial improvements in health and a larger reduction in health inequality than do the other economies. These more considerable changes in health play a role in improving welfare. Further, these changes in health reduce earnings inequality and, in turn, consumption inequality, thereby dampening welfare losses from changes in consumption attributable to more distortions due to increased income taxes.

In those cases without the strategic default option, expanding Medicaid more than the optimal level cannot bring about improvements in health as significant as those observed in the benchmark economy because households' medical spending is already substantially large in the baseline health insurance system. Therefore, there remains little room for health enhancement in those cases without the strategic default option. However, in the benchmark case, more margins are spared for changing health. Additionally, because the demand for health insurance in the benchmark case is considerably driven to manage health risks, expanding Medicaid improves welfare from better health outcomes by facilitating young and low households in managing the evolution of health risks in a preemptive manner. When this preventative channel is turned off—exogenous distribution of health shocks—because the management of health risks is no longer available, not expanding Medicaid is optimal. In contrast, in those cases without the strategic default option, differences in the optimal policies are not substantial according to the availability of the preventative medical spending channel because the demand for health insurance is driven to avoid the extreme cost of defaulting rather than to manage the evolution of health risks.

In summary, through the interactions between strategic default and preventative motives for healthcare, households' medical spending behavior and health insurance demand are altered, leading to considerable differences in the design of optimal health insurance policies. These results suggest that when bankruptcies and defaults are easily accessible, more redistributive healthcare reforms can bring about additional welfare gains through improvements in health. These better health outcomes are driven by young and low-income households that reduce their usage of ER and bankruptcy—implicit health insurance—and change their medical spending behavior to be more preventative.

Related Literature: This paper belongs to the stream of model-based quantitative macroeconomic literature that investigates the aggregate and distributional implications of health-related public policies.[3] Motivated by the seminal work of Grossman (1972), many of these studies have addressed health as an investment good that is affected by the behavior of investing efforts or resources. Zhao (2014) studied the impacts of Social Security on aggregate health spending in an endogenous health capital model. He finds that Social Security increases aggregate health spending by reallocating resources to the old whose marginal propensity to spending on health is high. The study of Zhao (2014) has a similarity to my work in the sense that both studies investigate the effect of another type of public policy on health spending, whereas my work focuses not on the effects of Social Security but on the impacts of defaults and bankruptcies. Jung and Tran (2016) investigated the implications of the Affordable Care Act in a general equilibrium model with investment in health capital. Although, as my work does, they examined health insurance policies in a health investment model, the focus of my work was different because their model did not consider the design of the optimal health insurance policy. Furthermore, they did not examine the effects of bankruptcies and defaults on healthcare spending.

Jung and Tran (2019) is also related to my work in the sense that they quantitatively investigates the optimal form of social health insurance. But, their focus is different from mine. Jung and Tran (2019) considers the optimal composition of the social health insurance system between private and public health insurance. My paper focuses on how credit and default affect the optimal provision of public health insurance. Cole, Kim and Krueger (2018) study the trade-off between the short-run benefits of generous health insurance policies and the long-run effects of health investment such as not smoking and exercising. The modeling strategy they use for health risks is similar to that used in this work because the distribution of health shocks depends on health status. In addition, their result for the optimal health insurance policy is similar to my work in the sense that providing full

[3] Suen et al. (2006); Attanasio et al. (2010); Ales et al. (2012); Ozkan (2017); Pashchenko and Porapakkarm (2013); Hansen et al. (2014); Yogo (2016); Jung and Tran (2016); Nakajima and Tüzemen (2017); Zhao (2017); Feng and Zhao (2018) are broadly included in this literature.

insurance is sub-optional. However, Cole, Kim and Krueger (2018) did not consider risk-sharing against health risks through defaults and the accumulation of physical capital. These risk-sharing channels are formalized in my model.

This paper also contributes to the consumer bankruptcy literature based on quantitative models. In this model, defaults and bankruptcies are based on the modeling setting proposed in Chatterjee, Corbae, Nakajima and Ríos-Rull (2007) in the sense that loan prices are characterized by individual states, medical expenses represent a primary driver of default, and ex-post defaults exist in general equilibrium. Livshits, MacGee and Tertilt (2007) is also closely related to this paper because they examined the effects of bankruptcy policies on consumption smoothing across states and over the life-cycle. In both Chatterjee et al. (2007) and Livshits et al. (2007), medical expenses are an important driving force of defaults, but neither study included the details of health insurance policies that reshape the distribution of default risks for medical reasons across households. This paper extends these studies by employing the institutional details of health insurance policies with endogenous health in the consumer bankruptcy framework.

This study is linked to a growing stream of the empirical literature addressing the relationship between health-related events and household financial well-being. Among these empirical studies, the most closely related paper is Mahoney (2015). He finds that ER and bankruptcy act as implicit health insurance because individuals with a lower financial cost of bankruptcy are more reluctant to purchase health insurance and make lower out-of-pocket medical payments conditional on the amount of care received. This study incorporates these institutional features in a structural model and finds that they are substantially important in designing the optimal health insurance policy because this implicit health insurance influences households' medical spending behavior.

The remainder of this paper proceeds as follows. Section 2 presents the model, defines the equilibrium, and explains the algorithm for the numerical solution. Section 3 describes the calibration strategy and the performance of the model. Section 4 presents the results of the policy analysis. Section 5 concludes this paper.

2 Model

2.1 Households

2.1.1 Household Environments

Demographics: The economy is populated by a continuum of households in J overlapping generations. This is a triennial model. They begin at age J_0 and work. They retire at age J_r, and the maximum survival age is $\bar{J}$. In each period, the survival rate is endogenously determined. The model has exogenous population growth rate n. There are 7 age groups,

$j_g: 23-34, 35-46, 47-55, 56-64, 65-76, 77-91$ and $92-100$.

Preferences: Preferences are represented by an isoelastic utility function over an aggregate that is itself a constant elasticity of substitution (CES) function over consumption c and current health status h_c,

$$u(c, h_c) = \frac{\left[\left(\lambda_u c^{\frac{v-1}{v}} + (1-\lambda_u) h_c^{\frac{v-1}{v}}\right)^{\frac{v}{v-1}}\right]^{1-\sigma}}{1-\sigma} + B_u \tag{1}$$

where λ_u is the weight on consumption, v is the elasticity of substitution between consumption c and health status h_c, and σ is the coefficient of relative risk aversion. Following Hall and Jones (2007), B_u is a sufficiently large constant to guarantee that the value of life is positive.

Labor Income: Working households at age j receive an idiosyncratic labor income y_j given by

$$\log(y_j) = \log(w) + \log(\bar{\omega_j}) + \phi_h \log(h_c) + \log(\eta) \tag{2}$$
$$\eta' = \rho_\eta \eta + \epsilon, \quad \epsilon \sim N(0, \sigma_\epsilon^2)$$

where w is the aggregate market wage, $\bar{\omega_j}$ is a deterministic age term, h_c is the current health status, ϕ_h is the elasticity of labor income y_j to health status h_c and η is an idiosyncratic productivity shock. η follows the above AR-1 process with a persistence of ρ_η and a persistent shock ϵ with a normal distribution.

Health Technology: In the model, health shocks interact with health capital. First, given health capital, I demonstrate how health shocks evolve. Second, I describe how health capital is intertemporally determined.

Given the empirical importance of the effect of ER on household finance (Mahoney (2015), Dobkin et al. (2018)), the model has two types of health shocks: emergency ϵ_e and non-emergency ϵ_n. These two shocks determine current health status h_c in the following way:

$$h_c = (1-\epsilon_e)(1-\epsilon_n)h, \quad h \in [0, 1] \tag{3}$$

where h_c is the current health status, ϵ_e is an emergency health shock, ϵ_n is a non-emergency health shock, and h is the stock of health capital. Emergency health shocks ϵ_e and non-emergency health shocks ϵ_n depreciate health capital h, and the remaining health capital becomes the current health status h_c. Because h is between 0 and 1, so is h_c. Note that current health status h_c is different from the stock of health capital h.

The data demonstrate that unhealthy and low-income households are more likely to visit ERs. This finding implies that some of the probability of emergency medical events is endogenously determined. To capture this, I model emergency medical events as follows.

Households face emergency health shocks ϵ_e only when they experience an emergency medical event. The probability of emergency medical events is as follows:

$$X_{er} = \begin{cases} 1 & \text{with probability } \frac{(1-h+\iota_e)}{A_{j_g}} \\ 0 & \text{with probability } 1 - \frac{(1-h+\iota_e)}{A_{j_g}} \end{cases} \tag{4}$$

where X_{er} is a random variable of emergency medical events, and h is the stock of health capital. Regarding the probability function of emergency medical events, ι_e is the scale parameter, and A_{j_g} is the age group effect parameter. ι_e controls the average probability of emergency room events, and A_{j_g} influences the difference in probability across age groups. Households experience an emergency medical event $X_{er} = 1$ with probability $(1 - h + \iota_e)/A_{j_g}$. This equation implies that health capital h determines the probability of emergency medical events.[4] When a household has more health capital, it is less likely to experience emergency medical events.

Conditional on an emergency medical event, $X_{er} = 1$, emergency health shocks ϵ_e evolve as follows:

$$\epsilon_e = \begin{cases} \epsilon_{se} & \text{with probability } p_{se} \text{ conditional on } X_{er} = 1 \\ \epsilon_{ne} & \text{with probability } 1 - p_{se} \text{ conditional on } X_{er} = 1 \end{cases} \tag{5}$$

where

$$0 < \epsilon_{ne} < \epsilon_{se} < 1 \quad \text{and} \quad 0 < m_e(\epsilon_{ne}) < m_e(\epsilon_{se})$$

where (ϵ_{ne}) ϵ_{se} is a (non-) severe emergency health shock, p_{se} is the probability of the realization of a severe emergency health shock ϵ_{se} and $(m_e(\epsilon_{ne}))$ $m_e(\epsilon_{se})$ is the medical cost of a (non-) severe emergency medical shock. A severe emergency health shock is larger than a non-severe emergency health shock. Examples of severe emergency health shocks include ER events such as heart attacks and car accidents. Non-severe emergency health shocks imply less serious ER events such as allergies or pink eye. These emergency health shocks incur emergency medical costs $m_e(\cdot)$. Note that emergency medical costs $m_e(\cdot)$ are not a choice variable; rather they are a function of emergency health shock $\epsilon \in \{\epsilon_{ne}, \epsilon_{se}\}$. Severe emergency health shocks incur higher medical costs than non-emergency health shocks, $m_e(\epsilon_{ne}) < m_e(\epsilon_{se})$.

The model assumes that spending on emergency medical treatments is given as a shock, which makes one be worried whether it fails to capture the moral hazard behavior of low-income house-

[4] For example, let us assume that $A_{j_g} = 1$ and $\iota_e = 0$, and I compare two households: household A with $h = 0.5$ and household B with $h = 0.8$. Then, the probability of emergency medical events for household A is 0.5, whereas that for household B is 0.2.

holds in the usage of emergency rooms. Note that frequent usage might be due not only to moral hazard behavior but also to adverse selection stemming from poor health status. If the impact of moral hazard behavior is quantitatively the main driving force behind the income ingredient of ER visits, the ER cost might systematically differ across income groups, for example, because either the rich or the poor spend more on ER healthcare conditional on visiting an ER. However, using data from the Medical Expenditure Panel Survey (MEPS), I find that the amount charged for ER events is unrelated to the income level conditional on visiting an ER.[5] This finding suggests that adverse selection is quantitatively important in driving the income gradient of ER visits, which supports the choice of the ER setting.[6]

Non-emergency health shock ϵ_n evolves as follows:

$$\epsilon_n \sim TN\left(\mu = 0, \sigma = \frac{((1/h) - 1 + \iota_n)^{\alpha_n}}{B_{j_g}}, a = 0, b = 1\right) \tag{6}$$

where $TN(\mu, \sigma, a, b)$ is a truncated normal distribution on bounded interval $[a, b]$, for which the mean and standard deviation of its original normal distribution are μ and σ, respectively. Let us denote σ as the dispersion of the distribution of non-emergency health shocks. The dispersion σ is a function of health capital h with three parameters: ι_n, α_n and B_{j_g}. Regarding the dispersion of the distribution of non-emergency health shocks, ι_n is the scale parameter, α_n is the curvature parameter, and B_{j_g} is the age group effect parameter. ι_n controls the overall size of non-emergency health shocks, α_n determines the extent to which differences in health capital affect the level of dispersion σ, and B_{j_g} influences the extent to which the level of dispersion σ differs across age groups.

Health capital determines the distribution of non-emergency health shocks through its dispersion σ. Figure 1 illustrates how health capital determines the distribution of non-emergency health shocks. The horizontal axis indicates the size of non-emergency health shocks, and the vertical axis indicates the value of the probability density function of non-emergency health shocks. Given values of parameters ι_n, α_n and B_{j_g}, the dispersion of non-emergency health shocks, $\sigma = \frac{((1/h)-1+\iota_n)^{\alpha_n}}{B_{j_g}}$, decreases with health capital h. Thus, the probability density function of non-emergency health shocks tends to be concentrated more around 0 if the level of health capital h is high, as the left-hand side graph in Figure 1 shows. This concentration means that those who accumulate a larger stock of health capital are less likely to confront a large non-emergency health shock. On the other hand, if a household has a low stock of health capital, the dispersion of the distribution of non-emergency health shocks is high, as the right-hand side graph in Figure

[5]This result is presented in Appendix A.

[6]The model succeeds in generating the gap in ER visits across income groups, which will be presented in the section on Model Performance.

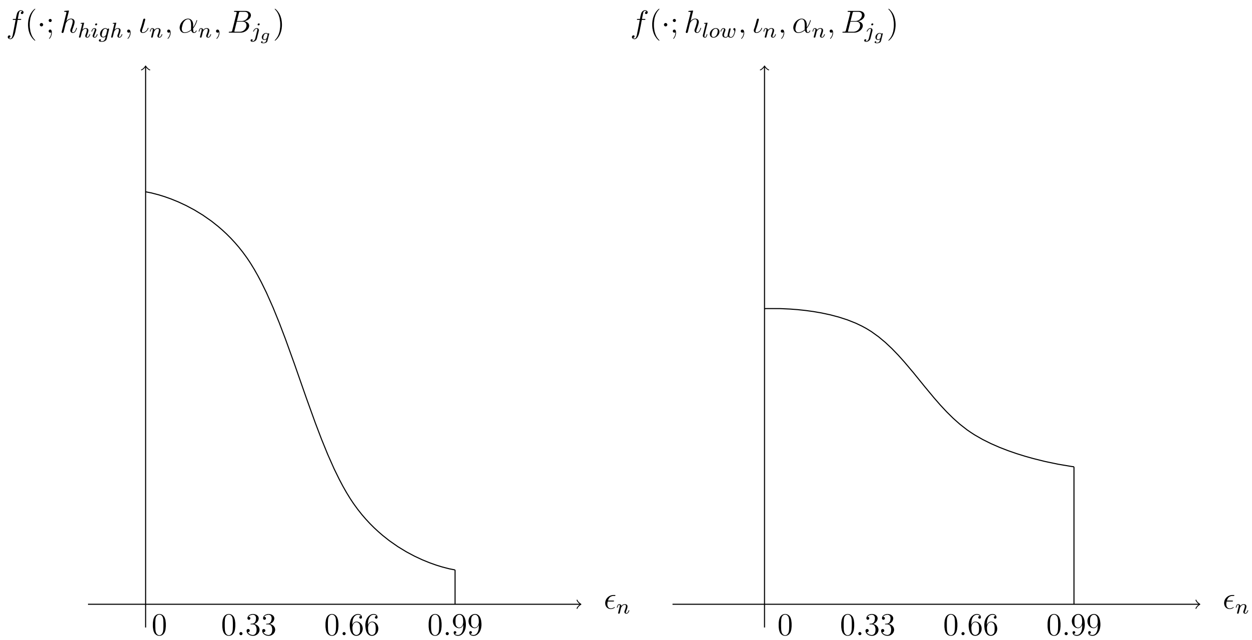

Figure 1: Distribution of Non-emergency Health Shocks across Levels of Health Capital ($h_{high} > h_{low}$)

1 shows. This dispersion means that this agent is more likely to face a substantial non-emergency health shock.

The merit of the setting for non-emergency medical events is worth noting: it enables a well-known criticism of the model of Grossman (1972) to be addressed. His model predicts that the demand for medical and health service is positively related to health, while their relation is negative in the actual data. In the model, motivated by Galama and Kapteyn (2011); Ozkan (2017), health capital affects the distribution of health shocks such that when a person has more health capital, he is less likely to experience severe or emergency medical events. This prediction implies that healthier households spend less on medical and health services, which is consistent with the empirical findings.[7]

To model health technology, I modify the health capital model of Grossman (1972, 2000, 2017). In the spirit of his work, health capital evolves as follows:

$$h' = h_c + \psi_{j_g} m_n^{\varphi_{j_g}} = (1 - \epsilon_e)(1 - \epsilon_n)h + \psi_{j_g} m_n^{\varphi_{j_g}} \tag{7}$$

[7]Additionally, this setting makes it possible to account for salient interrelations between income and health risks observed in micro data. The data show that levels of health risks are negatively related to income, which is endogenously generated by the model due to the setting of non-emergency medical events. Appendix B describes the details of this finding.

where $h^{'}$ is the stock of health capital in the next period, h_c is the current health status, ϵ_e represents emergency health shocks, ϵ_n represents non-emergency health shocks, h is the stock of health capital in the current period, ψ_{j_g} is the efficiency of non-emergency health technology for age group j_g, and φ_{j_g} is the curvature of the non-emergency medical expenditure function. Households invest in health capital through non-emergency medical expenditures m_n. Then, households' total medical expenditures m are given by

$$m = m_n + m_e(\epsilon) \tag{8}$$

where m_n and $m_e(\epsilon_e)$ are non-emergency and emergency medical expenditures, respectively.

Note that only non-emergency medical expenditures m_n play a role in accumulating the stock of health capital in the next period, $h^{'}$. Emergency medical costs $m_e(\cdot)$ do not affect the accumulation of health capital. This choice reflects the institutional features of the EMTALA. As Black (2006) shows, the EMTATLA imposes a legal obligation to hospitals "to stabilize" patients, defined as providing emergency medical treatments to prevent material deterioration of the condition rather than to cure and improve the medical condition. This stabilization means that patients do not experience any worsening upon leaving the ER. Following this institutional feature, I assume that if a household faces an emergency health shock and does not get emergency medical treatments, its symptom (health shock) deteriorates. If it visits an ER, its treatments prevent medical conditions from worsening; however, these emergency treatments do not improve the conditions either. Because of the EMTALA, in the model, anyone with emergency medical conditions can visit ERs; therefore, emergency medical conditions always neither worsen nor improve.

Survival Probability: A household's survival probability is given by

$$\pi_{j+1|j}(h_c, j_g) = 1 - \Gamma_{j_g} \cdot \exp\left(-\nu h_c\right) \tag{9}$$

where $\pi_{j+1|j}(h^{'}, j_g)$ is the survival probability of living up to age $j+1$ conditional on surviving at age j in age group j_g with current health status h_c, Γ_{j_g} is the age group effect parameter of survival probability, and ν is the curvature of the survival probability with respect to the current health status h_c. The age group effect parameter of the survival probability Γ_{j_g} controls overall age effects up to death. Older age groups have a higher value of Γ_{j_g}. The curvature parameter of the survival probability ν captures differences in households' survival rate by current health status h_c.

Health Insurance: The health insurance plans in the benchmark model resemble those in the U.S.

For working-age households, the choice set of health insurance plans is given by

$$i \in \begin{cases} \{NHI, MCD, IHI, EHI\} & \text{if } y \leq \bar{y} \text{ \& } a \leq \bar{a} \text{ \& } \omega = 1 \\ \{NHI, MCD, IHI\} & \text{if } y \leq \bar{y} \text{ \& } a \leq \bar{a} \text{ \& } \omega = 0 \\ \{NHI, IHI, EHI\} & \text{if } [y > \bar{y} \vee a > \bar{a}] \text{ \& } \omega = 1 \\ \{NHI, IHI\} & \text{if } [y > \bar{y} \vee a > \bar{a}] \text{ \& } \omega = 0 \end{cases} \tag{10}$$

where i is health insurance status, NHI indicates no health insurance, MCD is Medicaid, and IHI is private individual health insurance. EHI is employer-based health insurance, y is individual income, $\bar{y}$ is the income threshold for Medicaid eligibility, a is individual assets, $\bar{a}$ is the asset test limit for Medicaid eligibility, and ω is the offer of EHI.

Medicaid MCD is available only for low-income and -wealth working-age households. Thus, if a household's income is below the income threshold for Medicaid eligibility $\bar{y}$ and its assets are below the asset threshold for Medicaid eligibility $\bar{a}$, it can use Medicaid. Otherwise, Medicaid MCD is not available as an insurance choice. Private individual health insurance IHI is available to every working-age household and has no requirements.

Employer-based health insurance EHI is available only to those who have an offer ω from their employers. Jeske and Kitao (2009) show that the offer rate of EHI tends to be higher in high-salary jobs. Thus, I assume that the offer of EHI is randomly determined and that the probability of an offer of EHI increases in households' income. Explicitly, the likelihood of an offer of EHI is given by $p(EHI|y)$, where y is households' taxable income. Following Jeske and Kitao (2009), the offer probability $p(EHI|y)$ increases with y.

The price of private health insurance is given by

$$p_{i'}(h_c, j_g) = \begin{cases} 0 & \text{if } i' = NHI \text{ or } i' = MCD \\ p_{IHI}(h_c, j_g) & \text{if } i' = IHI \\ p_{EHI} & \text{if } i' = EHI \end{cases} \tag{11}$$

where $p_{i'}(\cdot,\cdot)$ is a premium for health insurance i' for the next period, h_c is the current health status, and j_g is the age group. $p_{IHI}(h_c, j_g)$ is the health insurance premium of IHI for an insured individual whose health status is h_c within age group j_g, and p_{EHI} is the premium for EHI.

Private individual IHI and employer-based EHI health insurances differ in the price system. Individual health insurance has premiums $p_{IHI}(h_c, j_g)$, where h_c and j_g are the current health status and age group, respectively. This setting is based on the private individual health insurance market in the U.S. before the ACA. Private individual health insurance providers are allowed to differentiate prices by considering customers' pre-existing conditions, age and smoking status.

Contrary to the separating equilibrium of individual health insurance IHI, employer-based health insurance EHI has a single premium p_{EHI}. This price is independent of any individual state, which reflects that providers of employer-based health insurance in the U.S. cannot discriminate against employees based on their pre-existing conditions given the Health Insurance Portability and Accountability Act (HIPAA). In addition, a fraction $\psi_{EHI} \in (0, 1)$ of the premium p_{EHI} is covered by employers; therefore, insurance holders pay $(1-\psi_{EHI})\cdot p_{EHI}$. In addition, this payment $(1 - \psi_{EHI}) \cdot p_{EHI}$ is deducted from taxable income.

All health insurance plans provide coverage $q_i \cdot m$, and $(1-q_i)m$ becomes an out-of-pocket medical expenditure for an insured household. For example, for Medicaid holders, Medicaid MCD covers $q_{MCD} \cdot m$, and $(1 - q_{MCD}) \cdot m$ represents their out-of-pocket medical expenditures.

Retired households use Medicare. Medicare is public health insurance for elderly households. I assume that all retired households use Medicare and do not access the private health insurance market.

Default: The model has two types of defaults based on the source of debt: financial and non-financial. Following Chatterjee et al. (2007), Livshits et al. (2007) and Nakajima and Ríos-Rull (2019), financial default is modeled to capture the procedures and consequences of Chapter 7 bankruptcy.[8] Non-financial default is modeled to reflect the features of the EMTALA.

Households have either a good or bad credit history. A good credit history means that the credit record has no bankruptcy. A bad credit history implies that the household's credit record has a bankruptcy. The type of credit history determines the range of feasible actions of households in the financial markets.

Households with a good credit history can either save or borrow through unsecured debt. They can default on both financial and medical debts by filing for bankruptcy. In the period of filing for bankruptcy, these households can neither save nor dis-save. They have a bad credit history in the next period. If a household with a good credit history either has no debt or repays its unsecured debt, it preserves its good credit history in the next period.

Households with a bad credit history pay a cost for having a bad credit history that is as much as ξ portion of their earnings for each period. Households with a bad credit history can save assets but cannot borrow from financial intermediaries. Because of the absence of financial debt, they do not engage in financial default. However, they can default on emergency medical expenses because the EMTALA requires hospitals to provide emergency medical treatment to patients on credit regardless of their ability to pay the emergency medical costs. When households default on emergency medical expenses, they cannot save and preserve their bad credit history in the next period. Unless they default, with an exogenous probability λ, their bad credit history changes to

[8] Chapter 7 covers 70 percent of household bankruptcies. The other type of household bankruptcy is Chapter 13, which I do not address here.

good credit history in the next period.

Social Security: Social Security benefits in the U.S. depend on one's average earnings for the 35 years with the highest salary. To reflect this policy feature, I need to keep track of the entire earnings history of households or, at least, the average lifetime earnings in each period. These procedures bring additional state variables to the model. Considering a substantial number of states in my model, I avoid an additional computational burden by assuming that Social Security benefits are a function of earnings at retirement age, $\hat{y}^{LT}_{RET}$, as in Karahan and Ozkan (2013); Guvenen et al. (2014); Ozkan (2017). Following these papers, I employ the Social Security benefit schedule as follows:

$$ss(\hat{y}^{LT}_{RET}) = a_{ss} \times AE + b_{ss} \times \hat{y}^{LT}_{RET} \tag{12}$$

where AE is the average earnings in the population. I take the estimates of a_{ss} and b_{ss} in Guvenen et al. (2014).

Tax System and Government Budget: Taxes are levied from two sources: payroll and income. On the one hand, Social Security and Medicare are financed through payroll taxes. τ_{ss} is the payroll tax rate for Social Security, and τ_{med} is that for Medicare. On the other hand, income taxes cover government expenditure G, Medicaid q_d, and the subsidy for employer-based health insurance ψp_e. I choose the progressive tax function from Gouveia and Strauss (1994), which has been widely used in the macroeconomic policy literature. The income tax function $T(y)$ is given by

$$T(y) = a_0\{y - (y^{-a_1} + a_2)^{-1/a_1}\} + \tau_y y \tag{13}$$

where y is taxable income. a_0 denotes the upper bound of the progressive tax as income y goes to infinity. a_1 determines the curvature of the progressive tax function, and a_2 is a scale parameter. To use Gouveia and Strauss's (1994) estimation result, I take their estimates for a_0 and a_1. a_2 is calibrated to match a target that is the fraction of total revenues financed by progressive income taxes, which represent 65 percent (OECD Revenue Statistics 2002). τ_y is chosen to balance the total government budget.

2.1.2 Dynamic Household Problems

Households experience two phases of the life-cycle: working and retirement. For each period, households have either a good or bad credit history. A bad credit history means that the household has a record of a bankruptcy filing in its recent credit history. A good credit history implies that the household has no such record. Here, I focus on explaining the choice problem of working-age households with a good credit history because their choice problem is so informative as to understand the decisions that all the other types of households can make. Appendix C describes all types of dynamic household problems in recursive form.

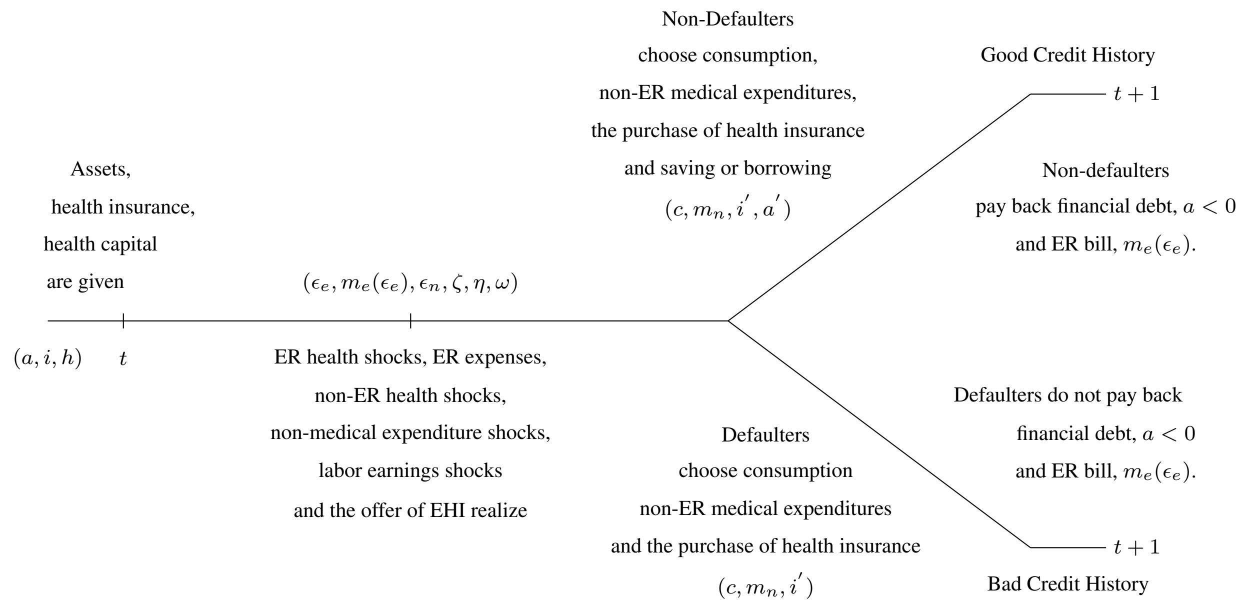

Figure 2: Time-line of Events for Working-age Households with a Good Credit History

Figure 2 shows the time-line of events for working-age households with a good credit history. Each period consists of two sub-periods. At the beginning of sub-period 1, assets a, health insurance status i and stock of health capital h are given from the previous period. Then, emergency health shocks ϵ_e, non-emergency health shocks ϵ_n, non-medical expenditure shocks ζ, uninsurable idiosyncratic shocks to the efficient units of labor η and an offer of employer-based health insurance ω are realized. These health shocks affect households' utility, labor productivity and mortality. Emergency health shocks ϵ_e incur specific sizes of non-discretionary medical costs $m_e(\epsilon_e)$.[9] Non-medical expenditure shocks ζ capture all possible reasons for filing for bankruptcy other than medical bills and bad luck in the labor market.[10] ζ follows a uniform distribution of $U[0, \bar{\zeta}]$.

Let $V_j^G(a, i, h, \epsilon_e, \epsilon_n, \zeta, \eta, \omega)$ denote the value of working-age households with a good credit

[9]This setting means that the amount of emergency medical costs is independent of households' income. This setting is supported by evidence in micro data. Using data from the MEPS, I find that, conditional on the use of emergency rooms, the amount of emergency room charges is unrelated to households' income. Further details are presented in Appendix A.

[10]Although medical expenses and shocks from the labor market are the main driving forces of bankruptcy, other motives also play a role. For example, Chakravarty and Rhee (1999); Chatterjee et al. (2007) note that marital disruption and lawsuits/harassment are also important factors to account for individuals' bankruptcy filing decision.

history in sub-period 1. They solve

$$V_j^G(a,i,h,\epsilon_e,\epsilon_n,\zeta,\eta,\omega) = \max\left\{v_j^{G,N}(a,i,h,\epsilon_e,\epsilon_n,\eta,\zeta,\omega), v_j^{G,D}(i,h,\epsilon_e,\epsilon_n,\eta,\omega)\right\} \tag{14}$$

where $v_j^{G,N}(a,i,h,\epsilon_e,\epsilon_n,\eta,\omega)$ is the value of non-defaulting with good credit history and $v_j^{G,D}(i,h,\epsilon_e,\epsilon_n,\eta,\omega)$ is the value of defaulting with a good credit history. The defaulting value, $v_j^{G,D}(i,h,\epsilon_e,\epsilon_n,\eta,\omega)$, does not depend on the current assets, a, and non-medical expenditure shocks, ζ, because all debts are eliminated with the default decision.

In sub-period 2, the available choices differ with the default decision in sub-period 1. Non-defaulting working-age households with a good credit history at age j in age group j_g solve

$$\begin{aligned} v_j^{G,N}(a,i,h,\epsilon_e,\epsilon_n,\zeta,\eta,\omega) = & \max_{\{c,\, a',\, i',\, m_n\geq 0\}} \frac{\left[\left(\lambda_u c^{\frac{v-1}{v}} + (1-\lambda_u) h_c^{\frac{v-1}{v}}\right)^{\frac{v}{v-1}}\right]^{1-\sigma}}{1-\sigma} + B_u \\ & + \beta\pi_{j+1|j}(h_c,j_g) \mathop{\mathbb{E}}_{\epsilon_e'|h',\epsilon_n'|h',\eta'|\eta,\omega'|y',\zeta'} \left[V_{j+1}^G(a',i',h',\epsilon_e',\epsilon_n',\zeta',\eta',\omega')\right] \end{aligned} \tag{15}$$

such that

$$\begin{aligned} & c + q(a',i',h';j,\eta)a' + p_{i'}(h_c,j_g) \\ & \leq (1-\tau_{ss}-\tau_{med})\left(w - c_{EHI}\cdot \mathbb{1}_{\omega=1}\right)\bar{\omega}_j h_c^{\phi_h}\eta + a + \kappa \\ & -(1-q_i^n)\, m_n - (1-q_i^e)\, m_e(\epsilon_e) - \zeta - T(y) \end{aligned}$$

$$\begin{aligned} & \zeta \sim U[0,\bar{\zeta}] \\ & h' = h_c + \varphi_{j_g} m_n^{\psi_{j_g}} = (1-\epsilon_n)(1-\epsilon_e)h + \varphi_{j_g} m_n^{\psi_{j_g}} \\ & y = \left(w - c_{EHI}\cdot\mathbb{1}_{\omega=1}\right)\omega_j h_c^{\phi_h}\eta + (1-q^{rf})a\cdot\mathbb{1}_{a>0} \\ & -(1-\psi_{EHI})\cdot p_{EHI}\cdot \mathbb{1}_{i'=EHI} \end{aligned}$$

the feasible set of health insurance choice i follows (10) , and

the health insurance premium $p_{i'}(h_c,j_g)$ follows (11).

Non-defaulting working-age households with a good credit history make decisions on consumption c, savings or debt a', the purchase of health insurance for the next period i' and non-emergency medical expenditures m_n. They earn labor income $\left(w - c_{EHI}\cdot\mathbb{1}_{\omega=1}\right)\bar{\omega}_j h_c^{\phi_h}\eta$ and accidental bequest κ. Note that I assume that some workers, randomly, get the opportunity to pool their health risks with others, which is EHI. They pay for it by deducting an amount c_{EHI} from the wage per effective labor unit w.[11] The portion of this wage reduction c_{EHI} satisfies the following zero-profit condition:

$$c_{EHI} = \frac{\psi_{EHI} \cdot p_{EHI} \cdot \sum_{j=J_0}^{J_r-1} \int \mathbb{1}_{\{i=EHI\}} \mu(d\mathbf{s}, j)}{\sum_{j=J_0}^{J_r-1} \int [\mathbb{1}_{\{\omega=1\}} \cdot \bar{\omega}_j h_c^{\phi_h} \eta] \mu(d\mathbf{s}, j)}. \tag{16}$$

where $\mu(\mathbf{s}, j)$ is the measure of households at age j of state $\mathbf{s}$

They pay out-of-pocket medical costs, the amount of which differs based on insurance status. If a household purchased health insurance in the previous period, the insurance company covers a part of its medical expenditures, $q_i^n m_n + q_i^e m_e(\epsilon_e)$, where q_i^n (q_i^e) is the fraction of non-emergency (emergency) medical expenditure that health insurance i covers.[12] The rest of the medical expense is the household's out-of-pocket medical expenditure, $(1-q_i^n)\, m_n + (1-q_i^e)\, m_e(\epsilon_e)$. If a household did not purchase health insurance in the previous period, the total medical expenditure is the same as the household's out-of-pocket medical expenditure, $q_i^n = q_i^e = 0$. They also pay costs incurred by non-medical expenditure shocks, ζ, which follows a uniform distribution of $U[0, \bar{\zeta}]$. These households pay a progressive tax $T(\cdot)$ based on their income y after deducting the premium of EHI charged on the insurance holder. They preserve their good credit history to the next period.

Health insurance plays both roles. First, health insurance decreases the marginal cost of investing in health capital by reducing the out-of-pocket medical expenses for non-emergency treatment. Second, health insurance partially insures the risk of emergency medical expense shocks. Since physical capital a can also play the same roles, how the relative price of health capital h to physical capital a changes is a key to determining the allocation of these two types of capital. Health insurance policies alter this relative price. If a health insurance policy subsidizes the purchase of health insurance to poor households, they face a lower relative price of health capital h to physical capital a than rich households and decide to increase their medical spending. This individual change in medical spending behavior results in a reallocation of health h and physical capital a over households.

[11] Some might think of such a situation as involving a lump-sum cost. However, this setting would bring about negative earnings, preventing defaulting households from having positive consumption.

[12] The fraction of medical expenses covered by health insurance differs between emergency and non-emergency treatments. According to the MEPS, the health insurance coverage rates are larger for the case of emergency medical treatments. More details are described in Section 3 (calibration).

Defaulting working-age households with a good credit history at age j in age group j_g solve

$$v_j^{G,D}(i,h,\epsilon_e,\epsilon_n,\eta,\omega) = \max_{\{c,\, i',\, m_n \geq 0\}} \frac{\left[\left(\lambda_u c^{\frac{v-1}{v}} + (1-\lambda_u) h_c^{\frac{v-1}{v}}\right)^{\frac{v}{v-1}}\right]^{1-\sigma}}{1-\sigma} + B_u$$
$$+ \beta \pi_{j+1|j}(h_c, j_g) \mathop{\mathbb{E}}_{\epsilon_e'|h',\epsilon_n'|h',\eta'|\eta,\omega'|y',\zeta'} \left[V_{j+1}^{B}(0,i',h',\epsilon_e',\epsilon_n',\zeta',\eta',\omega')\right] \tag{17}$$

such that

$$c + p_{i'}(h_c, j_g)$$
$$= (1-\tau_{ss}-\tau_{med})\left(w - c_{EHI}\cdot \mathbb{1}_{\omega=1}\right)\bar{\omega}_j h_c^{\phi_h}\eta - (1-q_i^n)m_n - T(y) + \kappa$$

$$h' = h_c + \varphi_{j_g} m_n^{\psi_{j_g}} = (1-\epsilon_n)(1-\epsilon_e)h + \varphi_{j_g} m_n^{\psi_{j_g}}$$
$$y = \left(w - c_{EHI}\cdot \mathbb{1}_{\omega=1}\right)\omega_j h_c^{\phi_h}\eta - (1-\psi_{EHI})\cdot p_{EHI}\cdot \mathbb{1}_{i'=EHI}$$

the feasible set of health insurance choice i follows (10) , and

the health insurance premium $p_{i'}(h_c, j_g)$ follows (11).

Defaulting working-age households with a good credit history make decisions on consumption c, health insurance i' for the next period and non-emergency medical expenditures m_n but can neither save nor dis-save during this period, $a' = 0$. As non-defaulting households do, out-of-pocket medical expenses depend on their health insurance status. However, contrary to the case of non-defaulting households, these households do not repay emergency medical expenses $m_e(\epsilon_e)$ because they have an exemption. They also have exemptions from the unsecured financial debt $a < 0$ and costs incurred by non-medical expenditure shocks ζ. Exemptions from those debts are given at the cost of their credit record. Their credit history becomes bad in the next period.

Although a majority of the decision-making problems of working-age households with a bad credit history are nearly identical to those of non-default households with good credit history, a few differences exist. Non-defaulters with a bad credit history are not allowed to borrow, $a \geq 0$, and pay a pecuniary cost of having a bad credit history equal to some fraction of their earnings, $\xi w \bar{\omega}_j h_c^{\phi_h}\eta$. In addition, their credit history is randomly determined in the next period. Defaulters with bad credit history pay a pecuniary cost of having a bad credit history equal to some fraction of their earnings, $\xi w \bar{\omega}_j h_c^{\phi_h}\eta$. They can neither save nor dis-save, $a' = 0$, and they make decisions on consumption c, health insurance for the next period i' and non-emergency medical expenditures m_n. Defaulters with bad credit history also do not repay emergency medical costs ϵ_e and non-medical expenses ζ; therefore, $(1-q_i^n)m_n$ becomes their out-of-pocket medical cost.[13] They

[13]They do not have any debt via the financial sector because those with bad credit cannot borrow regardless of their default decision.

maintain bad credit history in the next period.

Worth noting is the difference between filing for bankruptcy and defaulting. The bankruptcy system of this model is to capture the features of the Chapter 7 Bankruptcy in the U.S. Since refiling bankruptcy is not allowed on average for ten years in the U.S., I assume that only those who have a good credit history can file for bankruptcy. However, this does not mean that those who have a bad credit history cannot default on debts. Households with a bad credit history are allowed to default on non-financial debts such as ER bills and divorce-related costs.

Retired households do not have any labor income but receive Social Security benefits. Borrowing is not allowed for them, $a^{'} \geq 0$. I assume that all retired households have Medicare and do not use any private health insurance. At the beginning of each period, retired households face non-medical expenditure shocks ζ, emergency health shocks ϵ_e, and non-emergency health shocks ϵ_n. They make decisions on consumption c, savings or debt $a^{'}$, and non-emergency medical expenditures m_n. They pay out-of-pocket medical costs, $(1 - q^n_{med})m_n + (1 - q^e_{med})m_e(\epsilon_e)$. Retired households do not have the option to default on ER bills and financial debts.[14]

2.2 Firm

The economy has a representative firm. The firm maximizes its profit by solving the following problem:

$$\max_{K,N} \{zK^{\alpha}N^{1-\alpha} - wN - rK\} \tag{18}$$

where z is the total factor productivity (TFP), K is the aggregate capital stock, N is aggregate labor, and r is the capital rental rate. With the assumptions of the Cobb-Douglas production function and competitive pricing:

$$w = z\,\alpha\Big(\frac{K}{N}\Big)^{1-\alpha}, \quad r = z\,(1-\alpha)\Big(\frac{K}{N}\Big)^{\alpha}. \tag{19}$$

2.3 Financial Intermediaries

There are competitive financial intermediaries, and loans are defined by each state. This system implies that, given the law of large numbers, ex post-realized profits of lenders are zero for each type of loan. The lenders can observe the state of each borrower, and the loan price is determined

[14] I assume that retirees in my model do not default because it lessens the computational burdens that are already heavy in the current model, and their default rate is very low in the data (Figure 16 in Appendix F). In the U.S., bankruptcy filings are more actively involved with working-age individuals. In the model, retirees consistently sustain a positive consumption level thanks to Social Security benefits and accidental bequest.

using the default probability of good credit-status households and the risk-free interest rate.[15]

Specifically, the default probability of a household with a good credit history G, total debt $a^{'}$, insurance purchase status $i^{'}$, health capital for the next period $h^{'}$, current age j and current idiosyncratic earnings shock η in the next period is given by

$$d(a^{'}, i^{'}, h^{'}; j, \eta) = \sum_{\epsilon_n^{\prime}, \epsilon_e^{\prime}, \eta^{\prime}, \omega^{\prime}, \zeta^{\prime}} \pi_{\epsilon_e^{\prime}|h^{\prime}} \pi_{\epsilon_n^{\prime}|h^{\prime}} \pi_{\eta^{\prime}|\eta} \pi_{\omega^{\prime}|\eta^{\prime}} \pi_{\zeta^{\prime}} \mathbb{1}_{\{v^{G,N}(a^{\prime}, i^{\prime}, h^{\prime}, \epsilon_e^{\prime}, \epsilon_n^{\prime}, \eta^{\prime}, \omega^{\prime}, j+1) \leq v^{G,D}(i^{\prime}, h^{\prime}, \epsilon_e^{\prime}, \epsilon_n^{\prime}, \eta^{\prime}, \omega^{\prime}, j+1)\}} \tag{20}$$

where $\pi_{\epsilon_e^{\prime}|h^{\prime}}$ is the probability of an emergency health shock $\epsilon_e^{'}$ in the next period conditional on health capital $h^{'}$ for the next period, $\pi_{\epsilon_n^{\prime}|h^{\prime}}$ is the probability of a non-emergency health shock ϵ_n in the next period conditional on health capital $h^{'}$ for the next period, $\pi_{\eta^{\prime}|\eta}$ is the transitional probability of idiosyncratic shocks on earnings $\eta^{'}$ in the next period conditional on the current idiosyncratic shocks on earnings η, and $\pi_{\omega^{\prime}|\eta^{\prime}}$ is the probability of the offer of employer-based health insurance in the next period conditional on the idiosyncratic shock to earnings $\eta^{'}$ in the next period.

The zero-profit condition of the financial intermediaries that make a loan of amount $a^{'}$ to households of age j, current idiosyncratic labor productivity η, health capital $h^{'}$ for the next period, and health insurance $i^{'}$ for the next period is given by

$$(1 + r^{rf})\, q(a^{'}, i^{'}, h^{'}; j, \eta)\, a^{'} = (1 - d(a^{'}, i^{'}, h^{'}; j, \eta))\, a^{'} \tag{21}$$

where r^{rf} is the risk-free interest rate and $q(a^{'}, i^{'}, h^{'}; j, \eta)$ is the discount rate of the loan price.[16] Then, the discount rate of the loan price $q(a^{'}, i^{'}, h^{'}; j, \eta)$ is

$$q(a^{'}, i^{'}, h^{'}; j, \eta) = \frac{1 - d(a^{'}, i^{'}, h^{'}; j, \eta)}{1 + r^{rf}}. \tag{22}$$

2.4 Hospital

The economy has a representative agent hospital. For convenience, I denote household state s as $(a, i, h, \epsilon_e, \epsilon_n, \eta, \omega)$ and credit history as $v \in \{G, B\}$; the hospital earns the following revenue:

$$m_n(\mathbf{s}, j) + (1 - g_d(\mathbf{s}, j))\, m_e(\epsilon_e) + g_d(\mathbf{s}, j)\ \max(a, 0) \tag{23}$$

[15]Note that households with a bad credit history cannot access the financial market.

[16]Financial intermediaries consider both households' health insurance $i^{'}$ and health capital $h^{'}$ for the next period to price loans. This assumption is necessary to solve the model because no pooling equilibrium exists under symmetric information between lenders and borrowers. Solving default models under asymmetric information is beyond the scope of this paper.

where $m_n(\mathbf{s}, j)$ is the decision rule for non-emergency medical expenditures for households of state $\mathbf{s}$ at age j. $m_e(\epsilon_e)$ is emergency medical expenses for emergency health shocks ϵ_e, and $g_d(\mathbf{s}, j)$ is the decision rule for defaulting for households of state $\mathbf{s}$ at age j. All households always pay non-emergency medical expenditures m_n, regardless of whether they default because the hospital can assess patients' financial abilities before providing non-emergency medical treatment. However, the payment amount for emergency medical treatments $m_e(\epsilon_e)$ depends on individual default decisions. This is because the EMTALA requires hospitals to provide emergency medical treatment regardless of whether patients can pay their emergency medical bills. Non-defaulters repay all of their emergency medical expenditures to the hospital, but defaulters provide their assets instead of paying emergency medical expenses. If the asset level of these individuals is less than 0 (debt), the hospital receives no payment.

For each period t, hospital profits are given by

$$\sum_{j=J_0}^{\bar{J}} \int \{[m_n(\mathbf{s}, j) + (1 - g_d(\mathbf{s}, j))\, m_e(\epsilon_e) + g_d(\mathbf{s}, j)\ \max(a, 0)] \\ - \frac{(m_n(\mathbf{s}, j) + m_e(\epsilon_e))}{\Lambda}\}\mu(\mathbf{ds}, j) \tag{24}$$

where Λ is the mark-up of the hospital, and $\mu(\mathbf{s}, j)$ is the measure of households at age j of state $\mathbf{s}$. Following Chatterjee et al. (2007), mark-up Λ is adjusted to ensure zero-profits in the benchmark economy.[17]

I assume that the mark-up of the hospital Λ is fixed at the value in the calibrated economy across subsequent policy exercises. I rather adjust the scale of the overall medical expenses to reach zero-profits in equilibrium. This setting implies that changes in default risks are reflected in the medical expenses. When the number of defaults declines, for example, so does the price of medical services.

2.5 Equilibrium

Appendix E defines a recursive competitive equilibrium.

2.6 Numerical Solution Algorithm

Here, I describe the key ideas of the numerical solution algorithm. Appendix H demonstrates each step of the algorithm with details.

[17] Note that the object of default is here only emergency medical expenditures, while that in Chatterjee et al. (2007) is all medical expenditures.

Substantial computational burdens are involved in solving the model. The model has a large number of individual state variables, and loan prices depend on the state of individuals because of the endogenous default setting. Moreover, the model has many parameters that must be adjusted to match its cross-sectional and life-cycle moments with those in the data.

To solve the model, I apply an endogenous grid method to the asset holdings variable $a^{'}$ for the next period and discretize the health capital $h^{'}$ and health insurance $i^{'}$ variables for the next period because the variation in asset holdings $a^{'}$ is the largest among the endogenous state variables. The endogenous grid method that I use is an extension of Fella's (2014) method. Fella (2014) develops an endogenous grid method to solve models with discrete choices under an exogenous borrowing limit. One of the main contributions of Fella (2014) is an algorithm identifying concave regions over the solution set, to which Carroll's (2006) endogenous grid method is applicable. However, Fella's (2014) endogenous grid method is not directly applicable to models with default options because they do not have any predetermined feasible set of solutions. Based on the theoretical findings of Arellano (2008); Clausen and Strub (2017), I add a numerical procedure for finding the lower bound of feasible sets for the solution to Fella's (2014) algorithm that identifies concave regions over the solution sets, which allows me to use the endogenous grid method to solve this model.

Definition 2.6.1. For each $(\bar{i}^{'}, \bar{h}^{'}; j, \eta)$, $a^{'}_{rbl}(\bar{i}^{'}, \bar{h}^{'}; j, \eta)$ is ***the risky borrowing limit*** if

$$\forall a^{'} \geq a^{'}_{rbl}(a^{'}, \bar{i}^{'}, \bar{h}^{'}; j, \eta),$$
$$\frac{\partial q(a^{'}, \bar{i}^{'}, \bar{h}^{'}; j, \eta)a^{'}}{\partial a^{'}} = \frac{\partial q(a^{'}, \bar{i}^{'}, \bar{h}^{'}; j, \eta)}{\partial a^{'}}a^{'} + q(a^{'}, \bar{i}^{'}, \bar{h}^{'}; j, \eta) > 0.$$

I numerically compute the risky borrowing limit for each state and take it as the lower bound of feasible sets for solution $a^{'}$. To use the endogenous grid method, a first-order condition (FOC) is required. The following proposition guarantees the existence of an FOC and provides the form of the FOC, which is needed to use the endogenous grid method.

Proposition 2.6.1. *Given a pair of* (ϵ_e, ϵ_n)*, for any* $(\bar{i}^{'}, \bar{h}^{'}, j, \eta)$ *and for any* $a^{'} \geq a^{'}_{rbl}(\bar{i}^{'}, \bar{h}^{'}; j, \eta)$*,*
(i) the FOC of asset holdings $a^{'}$ *exists, and*
(ii) the FOC is as follows:

$$\frac{\partial q(a^{'}, \bar{i}^{'}, \bar{h}^{'}; j, \eta)a^{'}}{\partial a^{'}} \frac{\partial u(c, (1-\epsilon_e)(1-\epsilon_n)\bar{h})}{\partial c} = \frac{\partial W^{G}(a^{'}, \bar{i}^{'}, \bar{h}^{'}, \eta, j+1)}{\partial a^{'}} \tag{25}$$

where W^G *is the expected value of working-age households with a good history.*

Proof. See Appendix D. □

For each of the grid points for asset holdings $a^{'}$ for the next period, endogenous grid methods computes the endogenously-driven current assets $a(a^{'})$ by using the FOC in Proposition 2.6.1. Note that since the endogenously-driven current assets $a(a^{'})$ is located on an endogenous grid of current assets a, the decision rule and values on the exogenous grid must also be computed. The monotonicity of the decision rules and value functions allows endogenous grid methods to use interpolations to compute those on the exogenous grid for the current assets a.

I modify this interpolation step as follows. For each of the grid points for asset holdings $a^{'}$ of which the value is higher than zero, I use a linear interpolation as do other endogenous grid methods. However, for each of the grid points for asset holdings $a^{'}$ whose value is less than zero, I use the grid search method to avoid potentially unstable solutions resulting from numerical errors in calculating the derivative of the loan rate schedules $\frac{\partial q(a^{'},\bar{i}^{'},\bar{h}^{'};j,\eta)a^{'}}{\partial a^{'}}$. Although Proposition 2.6.1 proves that these loan rate schedules are differentiable, as Hatchondo et al. (2010) noted, the accuracy of the solution is sensitive to the method used to compute the derivative of loan rate schedules $\frac{\partial q(a^{'},\bar{i}^{'},\bar{h}^{'};j,\eta)a^{'}}{\partial a^{'}}$. I use the grid search method only for asset holdings $a^{'}$ that have a value less than zero. Despite the inclusion of this grid search method, this hybrid method substantially reduces the computational time because the method does not search the entire range of the assets grid. This grid search is operated only between the risky borrowing limit and zero assets. Moreover, using the monotonicity, I can repeatedly narrow the range of the feasible set of solutions in grid search.

3 Calibration

I calibrate the model to capture cross-sectional and life-cycle features of the U.S. economy before the ACA, because the ACA period is too brief to be regarded as the steady state of the U.S. healthcare system. To reflect these features, I take information from multiple micro data sets. In particular, I use the MEPS to capture salient cross-sectional and life-cycle dimensions on the use of emergency rooms, medical conditions, and medical expenditures.[18]

To calibrate the model, I separate the parameters into two groups. The first set of the parameters is determined outside the model. I choose the values of these parameters from the macroeconomic literature and policies. The other set of the parameters requires solving the stationary distribution of the model to minimize the distance between moments generated by the model and their empirical counterparts. Table 1 shows the values of the parameters resulting from the calibration, Table 2 summarizes the targeted aggregate moments and the corresponding moments generated by the model, and Figure 3 shows the targeted life-cycle moments and the corresponding model-generated

[18]The details of the data selection process are provided in Appendix A.

moments.

Table 1: Benchmark Parameter Values

Parameter	Description	Internal	Value
Demographics			
J_0	Initial age	N	23
J_r	Retirement age	N	65
$\bar{J}$	Maximum length of life	N	100
π_n	Population growth rate (percent)	N	1.2%
Preferences			
λ_u	Weight on consumption	Y	0.641
v	Elasticity of substitution b.w c and h$_c$	Y	0.321
σ	Risk aversion	N	3 (De Nardi et al. (2010))
β	Discount factor	Y	0.99
B_u	Constant in the utility	Y	35.573
Labor Income			
$\bar{\omega_j}$	Deterministic life-cycle profile	N	$\{0.0905,-0.0016\}^*$
ϕ_h	Elasticity of labor income to health status	N	0.594
ρ_η	Persistence of labor productivity shocks	Y	0.963
σ_ϵ	Standard deviation of persistent shocks	Y	0.280
Health Technology			
ι_e	Scale of ER health shocks	Y	0.314
A_{j_g}	Age group effect on ER health shocks	Y	{1, 1.227, 1.293, 1.324, 1.270, 1.194}
p_{se}	Probability of drastic ER health shocks	N	0.2
ι_n	Scale of non-ER health shocks	Y	0.02
α_n	Dispersion of non-ER health shocks	Y	0.54
B_{j_g}	Age group effect of non-ER health shock	Y	{1, 0.682, 0.445, 0.311, 0.203, 0.080}
ψ_{j_g}	Efficiency of health technology	Y	{0.371, 0.426, 0.534, 0.593, 0.635, 0.574}
φ_{j_g}	Curvature of health technology	Y	{0.197, 0.159, 0.241, 0.221, 0.323, 0.434}
Survival Probability			
Γ_{j_g}	Age group effect on survival rate	Y	{0.003, 0.01, 0.019, 0.049, 0.107, 0.295, 0.62}
ν	Elasticity of survival rate to health status	N	0.226 (Franks et al. (2003))
Health Insurance			
$\bar{y}$	Income threshold for Medicaid eligibility	Y	0.104
$\bar{a}$	Asset test limit for Medicaid eligibility	N	0.65 (Pashchenko and Porapakkarm (2017))
(q^n_{MCD}, q^e_{MCD})	Medicaid coverage rates	N	(0.7,0.8)
(q^n_{IHI}, q^e_{IHI})	IHI coverage rates	N	(0.55,0.7)
(q^n_{EHI}, q^e_{EHI})	EHI coverage rates	N	(0.7,0.8)
(q^n_{med}, q^e_{med})	Medicare coverage rates	N	(0.55,0.75)
p_{med}	Medicaid premium	N	0.021
$p(EHI\|y)$	EHI offer rate	N	Appendix I
ψ_{EHI}	Subsidy for EHI	N	0.8
c_{EHI}	Portion of wage deduction from EHI	Y	0.022

Table 1 continued from previous page

Parameter	Description	Internal	Value
ξ_{IHI}	Markup for IHI	Y	1.02
β_{EHI}	Scale of the prob. fnc of EHI offer	Y	0.156
Default			
ξ	Cost of having a bad credit history	Y	0.137
λ	1/Duration of having a bad credit history	N	0.1
$\bar{\zeta}$	Non-medical expense shocks $\zeta \sim U[0, \bar{\zeta}]$	Y	0.043
Tax and Government			
ss_0	Constant term for pension sched	N	0.168 (Guvenen et al. (2014))
ss_1	Income-related term for pension sched	N	0.3546 (Guvenen et al. (2014))
τ_{ss}	Social Security tax	N	0.125
τ_{med}	Medicare payroll tax	N	0.029
G	Government spending/ GDP	N	0.18
a_0	Upper bound of the progressive tax fnc	N	0.258 (Gouveia and Strauss (1994))
a_1	Curvature of the progressive tax fnc	N	0.768 (Gouveia and Strauss (1994))
a_2	Scale of the progressive tax fnc	Y	1.402
τ_y	Proportional tax rate	Y	0.095
Firm			
z	Total factor productivity	Y	0.669
θ	Capital income share	N	0.36
δ	Depreciation rate	N	0.08
Hospital			
Λ	Mark-up of hospital	Y	1.03

The parameter values are annualized to be consistent with those in the data. One unit of output in the model is the U.S. GDP per capita in 2000 ($\$36,245.5$).

Demographics: The model period is triennial. Households enter the economy at age 23 and retire at age 65. Since the mortality rate is endogenous, life spans differ across households. Their maximum length of life is 100 years. These values correspond to $J_r = 15$ and $\bar{J} = 26$. The chosen population growth rate π_n is 1.2 percent, which is consistent with the annual population growth rate in the U.S.

Preferences: Preferences are represented by a power utility function over a CES aggregator over consumption and health status. λ_u is the weight of non-medical consumption on the CES aggregator in the utility function. λ_u is chosen to match the ratio of total medical expenditures to output of 0.163 in the National Health Expenditure Accounts (NHEA). υ is the elasticity of substitution between non-medical consumption and current health status, which is chosen to target the correlation between non-medical consumption and medical expenditures, which is 0.158 in the PSID. The value of υ is 0.321, implying that consumption is complementary with health. This result is consistent with the empirical findings of Finkelstein et al. (2013). σ is the coefficient of relative

Table 2: Targeted Aggregate Moments

Moment	Empirical value	Model value
Risk-free interest rate (percent)	4	4
AVG of bankruptcy rates (percent)	1.22	1.21
VSLY/AVG Consumption	6.25	6.25
Fraction of bankruptcy Filers with Medical Bills	0.62	0.63
Total medical expenditures/GDP	0.163	0.171
CV of medical expenditures	2.67	2.56
Corr b.w. consumption and medical expenditures	0.158	0.158
Autocorrelation of earnings shocks	0.957	0.957
STD of log earnings	0.917	0.918
Fraction of ER users aged b.w. 23 and 34	0.125	0.126
AVG of health shocks b.w. ages of 23 and 34	0.116	0.118
Individual health insurance take-up rate	0.125	0.125
Employer-based health insurance take-up rate	0.686	0.680
Working-age households' Medicaid take-up rate	0.044	0.044

The model period is triennial . I transform triennial moments into annual moments. One unit of output in the model is the U.S. GDP per capita in 2000 $(\$36,432.5)$.

risk aversion, according to De Nardi et al. (2010). β is the discount factor of households, which is selected to match an equilibrium annual risk-free interest rate of 4 percent. To determine B_u, following Glover et al. (2020), I assume the value of a statistical life year (VSLY) to be 6.25 times the average annual consumption per capita. As in Glover et al. (2020), I adjust B_u to make the utility value of the extra year of life equal to the VSLY:

$$\frac{\left[\left(\lambda_u \bar{c}^{\frac{v-1}{v}} + (1-\lambda_u)\bar{h}_c^{\frac{v-1}{v}}\right)^{\frac{v}{v-1}}\right]^{1-\sigma}}{1-\sigma} + B_u = \frac{\partial u(\bar{c}, \bar{h}_c)}{\partial c} \times 6.25\bar{c} \tag{26}$$

where $\bar{c}$ is the average consumption per capita and $\bar{h}_c$ is the average health status of individuals.

Labor Income: To obtain the deterministic life-cycle profile of earnings $\bar{\omega}_j$, I take the following steps. First, in the MEPS, I choose the Physical Component Score (PCS) as the counterpart of health status in the model.[19] I normalize the PCS by dividing all of the observations by the highest score in the sample. Second, exploiting the panel structure of the MEPS data, I regress the difference in log labor income on the differences in age squared, education, sex and the PCS.[20] I choose the summation of the age and age-squared terms as the deterministic life-cycle profiles of

[19]The PCS is a continuous health measure between 0 and 100 that indicates an individual's physical condition.

[20]This setting absorbs individual fixed effects. Further, one might be concerned about endogeneity given the reverse causality from labor income to health, but empirical studies including Currie and Madrian (1999) and Deaton (2003) show that it is difficult to find a direct effect of labor income on health.

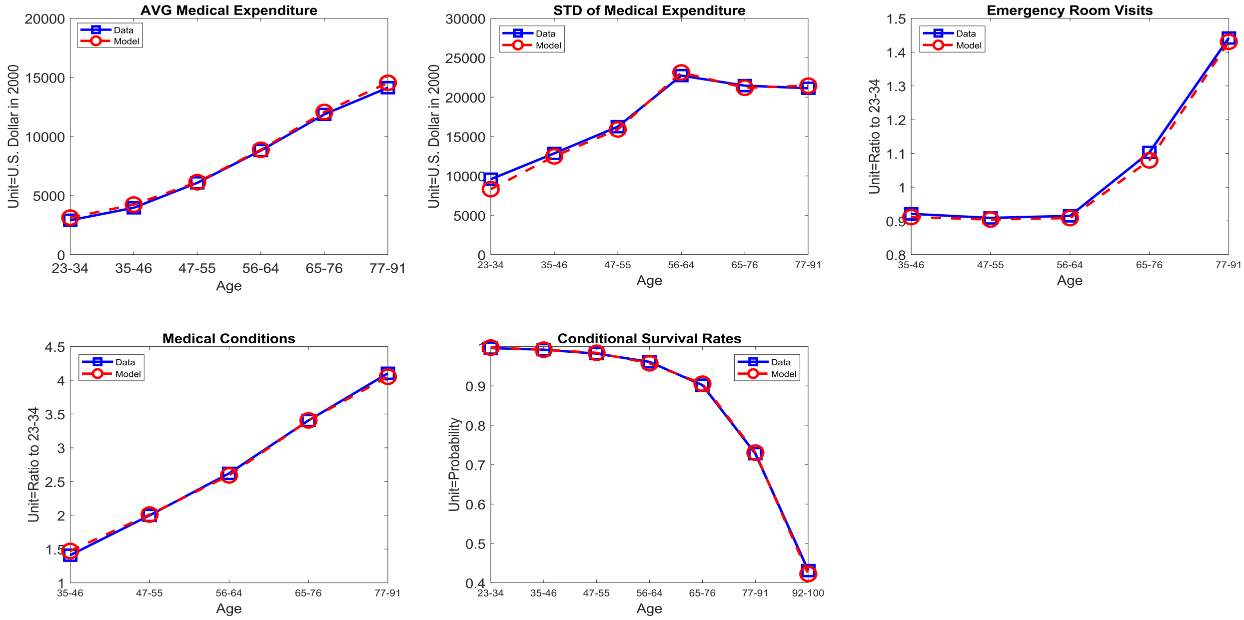

Figure 3: Targeted Life-cycle Moments

earnings $\bar{\omega_j}$. ϕ_h is set based on the estimate of the coefficient of the PCS. ρ_η is chosen to match the autocorrelation of the idiosyncratic component $\phi_h \log(h_c) + \log(\eta)$ with the autocorrelation of earnings shocks without the health component of 0.957 in Storesletten, Telmer and Yaron (2004). σ_ϵ is chosen to target a standard deviation of 0.917 for the log earnings for prime aged workers in the MEPS.

Health Technology: I choose the scale parameter of the function for emergency health shocks ι_e to target the average fraction of emergency room users aged between 23 and 34, which is 0.125 in the MEPS. A_g governs differences in emergency room visits by age group and is chosen to match the ratio of the fraction of emergency room visits for each age group to that of households aged between 23 and 34. The upper-right panel of Figure 3 shows that these ratios observed in the data are close to those generated by the model. p_{se} is the probability of an extreme emergency medical event conditional on the occurrence of an emergency medical event. I model these extreme emergency medical events as emergency events that incur the top 20 percent of emergency medical expenses. ι_n is chosen to target the average health shocks of households aged between 23 and 34, which is 0.125 in the MEPS. α_n determines the degree of differences in health shocks across levels of health capital. It is selected to target the coefficient of variation of medical expenditures of 2.67 in the MEPS. B_{j_g} is set to match the ratio of the average of medical conditions transformed by health shocks for each age group to that of households aged between 23 and 34. The lower-left panel of Figure 3 shows that the model generates a similar age profile of medical conditions. ψ_{j_g}

is set to match the average of medical expenditures for each age group. φ_{j_g} is chosen to target the standard deviation of medical expenditures for each age group. The upper-left and upper-middle panels of Figure 3 show that the life-cycle profiles of the mean and standard deviation for medical expenditures in the data are close to those generated by the model. Figure 4 shows the cumulative distribution of medical expenditures between the model and the data, which implies that the distribution of model-generated medical expenditure is close to the empirical distribution.

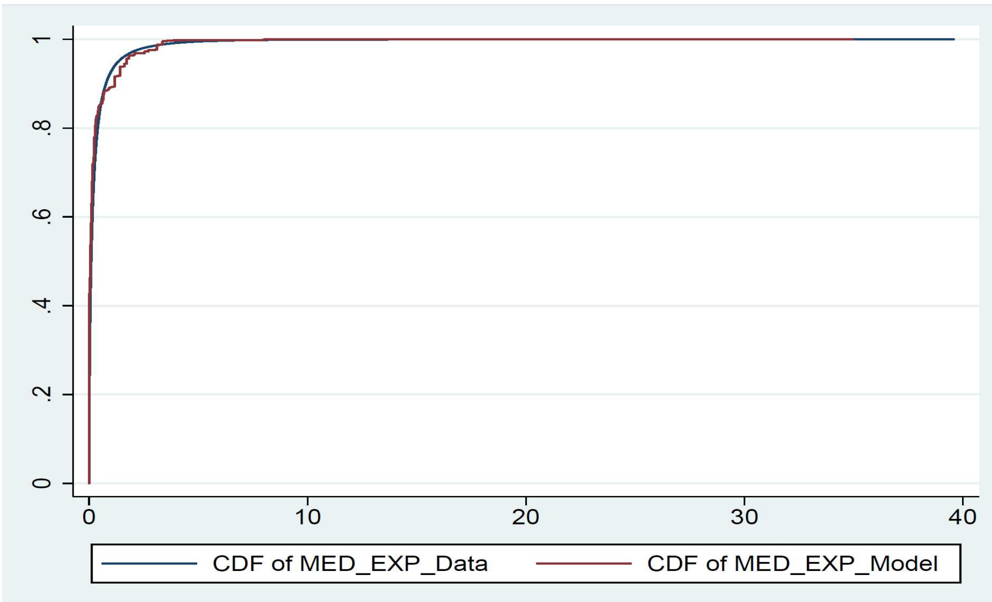

Figure 4: Cumulative Distribution of Medical Expenditure (Unit=U.S. GDP per capita in 2000 ($\$36,432.5$))

Survival Probability: Γ_{j_g} controls the disparities in survival rates across age groups. Γ_{j_g} is chosen to target the average survival rate for each age group, which is calculated based on Bell and Miller (2005). ν governs the predictability of the PCS for the survival rate. I choose ν based on the estimate of Franks, Gold and Fiscella (2003). They use a somewhat different type of health measure from the MEPS. Whereas the MEPS uses the SF-12 as its PCS, Franks, Gold and Fiscella (2003) choose the SF-5 as their PCS. Although the types of PCS differ, Østhus, Preljevic, Sandvik, Leivestad, Nordhus, Dammen and Os (2012); Lacson, Xu, Lin, Dean, Lazarus and Hakim (2010); Rumsfeld, MaWhinney, McCarthy Jr, Shroyer, VillaNueva, O'brien, Moritz, Henderson, Grover, Sethi et al. (1999) find that different types of PCS are highly correlated. Based on their finding, I use the estimate of Franks, Gold and Fiscella (2003) by transforming their five-year result to a three-year value and rescaling the 0-100 scale into the relative scale of the model. Recall that, in the model, health status is represented by a health status relative to the healthiest in the economy.

Health Insurance: $\bar{y}$ is the income threshold for Medicaid eligibility that is chosen to match the percentage of Medicaid takers among working-age households, which is. 4.4 percent in the MEPS.

$\bar{a}$ is the asset test limit for Medicaid eligibility, of which the value is 0.65, following Pashchenko and Porapakkarm (2017).[21] Health insurance coverage rates, q^e_{MCD}, q^e_{IHI}, q^e_{EHI} and q^e_{med}, (q^n_{MCD}, q^n_{IHI}, q^n_{EHI} and q^n_{med}), are chosen to match the fraction of (non-) emergency out-of-pocket medical expenditures among the total medical expenditures for each type of health insurance. The Medicare premium p_{med} is set to 2.11 percent of GDP per capita, which is based on the finding in Jeske and Kitao (2009). The offer rates of employer-based health insurance $p(EHI|y)$ are set to target those across earnings levels in the MEPS. For each age group j_g, I run a logit regression of the offer of EHI on the earnings, earnings-squared, and earnings-cubed. Then, the predicted offer rate for age group j_g is

$$P_{j_g}(\omega = 1|y) = \frac{\exp(\beta_{EHI} + \beta_{j_g,0} + \beta_{j_g,1}y + \beta_{j_g,2}y^2 + \beta_{j_g,3}y^3)}{1 + \exp(\beta_{EHI} + \beta_{j_g,0} + \beta_{j_g,1}y + \beta_{j_g,2}y^2 + \beta_{j_g,3}y^3)}. \tag{27}$$

I take the values of $\beta_{j_g,0}$, $\beta_{j_g,1}$, $\beta_{j_g,2}$, and $\beta_{j_g,3}$ from the estimation, which are reported in Appendix I. β_{EHI} is adjusted to match the take-up rate of EHI in the data. The subsidy for employer-based health insurance ψ_{EHI} is chosen such that employer-based health insurance takers pay 20 percent of the premium. c_{EHI} is chosen to satisfy the zero-profit condition to finance the subsidy of EHI. ξ_{IHI} and ξ_{EHI} are set to the take-up rates of IHI and EHI, respectively.

Default: The cost of bad credit history ξ is chosen to match the average Chapter 7 bankruptcy rate in Nakajima and Ríos-Rull (2019). λ is chosen to match the average duration of exclusion, which is 10 years for Chapter 7 bankruptcy filing. $\bar{\zeta}$ is selected to match the fraction of bankruptcy filer with medical bills in Himmelstein et al. (2009).

Tax and Government: ss_0 and ss_1 are taken from Guvenen et al. (2014). The Social Security τ_{ss} and Medicare tax rates τ_{med} are set to 12.5 percent and 2.9 percent, respectively. Non-medical government spending is set at 18 percent of U.S. GDP. a_0 and a_1 are taken from Gouveia and Strauss (1994). As in Jeske and Kitao (2009) and Pashchenko and Porapakkarm (2013), the scale parameter of the income tax function a_2 is chosen to match the fraction of tax revenue financed by progressive income taxation of 65 percent, which is the average value of the OECD member countries. The proportional income tax τ_y is chosen to balance the government budget constraint.

Firm: TFP z is chosen to normalize output to 1. θ is chosen to reproduce the empirical finding that the share of capital income is 0.36. The annual depreciation rate δ is 8 percent.

[21] Pashchenko and Porapakkarm (2017) internally calibrated this parameter to match the fraction of Medicaid enrollees aged 51-64 who have assets less than $10,000$, which is 49% in the HRS. Matching this fraction in my model is difficult because labor supply is set to be inelastic, which leads to a strong, positive correlation between assets and earnings. At the value of $\bar{a}$ in Pashchenko and Porapakkarm (2017), the fraction generated by my model is much larger, at 96 percent. When I set up $\bar{a}$ to be $10,000$ (minimum), the fraction of Medicaid enrollees aged 51-64 who have assets less than $10,000$ changes little, and is still too high, 93 percent.

Hospital: Following Chatterjee et al. (2007), hospital mark-up Λ is chosen to represent the zero-profit condition of the hospital in the benchmark economy.

3.1 Model Performance

Appendix F demonstrates the performance of the model by assessing the consistency of its untargeted results with its empirical counterparts.

4 Results

In this section, I examine how credit and default affect households' medical spending and health insurance demand behaviors, interacting with preventative medical motives. Next, I investigate the implications of these household behaviors in designing the optimal health insurance policy.

For the first analysis, an issue is that the two channels, access to credit and strategic default, move together when the cost of defaulting is adjusted. For example, increasing the penalty of defaulting not only makes the strategic default option more costly but also provides households with more access to credit. These forces would have different roles in determining households' medical spending behaviors. For example, more access to credit might help households smooth their medical spending over time, but the strategic default option would lead them to rely more on ER and bankruptcy. The first force could facilitate households' preventative managements in health, but the second one could act oppositely. Thus, isolating each force is required to understand their role in households medical spending behaviors.

To do so, I set up three cases: the benchmark case ("Benchmark"), a costly default case ("Costly Default"), no borrowing case ("No Borrowing"). Following the literature, to set up this costly default case, I turn off the strategic default option by imposing an extremely large penalty on defaulting. Specifically, I restrict defaulting households to having no labor income and to getting by with a small amount of accidental bequest until their credit history recovers to good.[22] However, note that this extreme penalty not only eliminates strategic default but also plunges the value of defaulting and thus the expected probability of defaulting, thereby providing households with more access to credit. Thus, I set up the economy with no borrowing by turning off the borrowing channel in the economy with costly default. Table 3 summarizes the features of the three economies through the availability of strategic default and borrowing.

[22]This setting implies an annual income of approximately 1240 dollars, and this restriction lasts an average of 10 years. A small income is required to maintain a positive value of life. Additionally, one might consider not allowing the strategic default option mechanically without any penalty. This setting is not feasible because the monotonicity of the expected value function does not hold around the default region.

Table 3: Features of the Three Economies

	Benchmark	Costly Default	No Borrowing
Strategic Default	O	X	X
Borrowing	O	O	X

Across the three economies, I examine how medical spending behaviors differ according to the availability of access to credit and the strategic default option. Furthermore, I investigate how these differences are shaped through the interaction of preventative motives for healthcare by turning off the endogenous channel of the distributions of health shocks. I shut down this channel by assuming the distributions of health shocks to be exogenous and identical within each age group. More specifically, for each age group, the dispersion of distribution for non-emergency health shocks is set to be the average dispersion over individuals in the benchmark case with the endogenous distribution of non-emergency health shocks. Similarly, for each age group, the probability of ER events is set to be the average probability of ER events in the benchmark case with the endogenous distribution of emergency health shocks. Note that in these settings, health capital has no impact on the distributions of health shocks.

Then, in the policy exercises, I define the social welfare function and use it to find the optimal health insurance policy in these three economies. Additionally, I analyze the role of preventative medical spending motives in designing the optimal policy by shutting down the endogenous channel of the distributions of health shocks.

4.1 Effects of the Strategic Default Option on the Economy under the Baseline Health Insurance System

Figure 5 shows the discounted loan rate schedules, $q(a^{'})$, according to whether the defaults are costly. The left panels display the discounted loan rate schedules by idiosyncratic labor productivity z across ages in the benchmark economy, and the right panels do so in the economy with costly default. Comparing the left with the right panels implies that this costly default reduces borrowing costs and provides households with more access to credit. Since the inverse of the discounted loan rate, $1/q(a^{'})$, is the interest rate for borrowing, a larger loan rate implies a lower borrowing cost. For example, the top-left panel shows that when households aged 21-23 with $z = 10$ wish to borrow as much as 20,000 dollars, they cannot borrow because the interest rate is not well-defined (infinite). However, the top-right panel implies that in the economy with costly default, the same type of households could borrow that amount of money with an interest rate of 42 percent (1/0.7). Furthermore, Figure 5 shows that this gap is not restricted to a specific age group or productivity type. The economy with costly default has lower borrowing costs and more access to credit for all

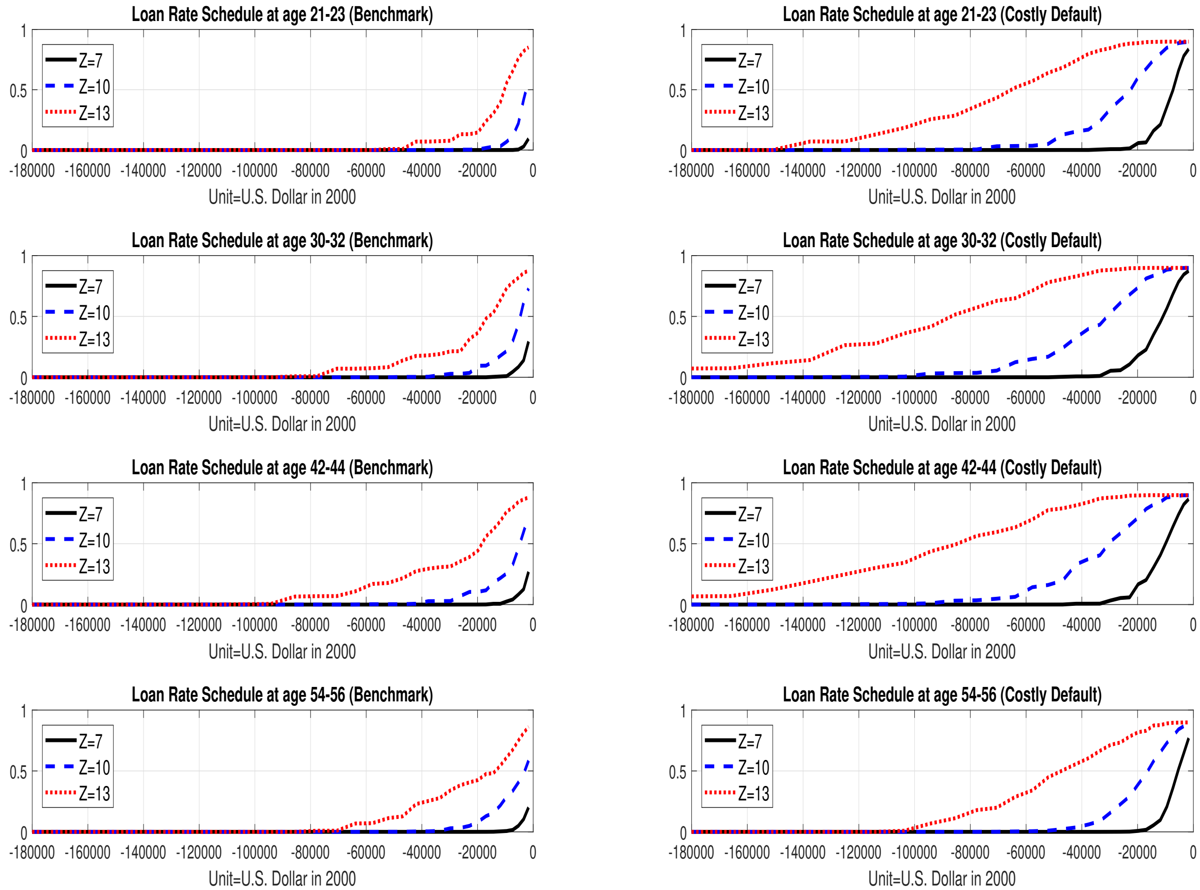

Figure 5: Discounted Loan Rate Schedules by Cost of Default

ages and individual productivity types.

Figure 6 displays the life-cycle profiles of net worth over the life-cycle across the three economies. Figure 6 shows that when defaults are costly, households accumulate more assets during the working-age period. This pattern is common to all wealth groups. Although turning off the strategic default allows young households to borrow more, they instead increase their asset accumulation over the working-age period across wealth groups. Households aged 32-34 in the 20th percentile of net worth in the benchmark economy have an average net worth of as much as -800 dollars, whereas those in the economy with costly default and no borrowing have as much as 1,800 dollars. Households in the 80th percentile of net worth have much smaller gaps between the benchmark economy and the economy with costly default. This difference implies that these precautionary motives against costly default play a substantial role in increasing savings over the working-age period. Table 13 in Appendix J also implies that although the extreme cost of defaulting provides more access to credit and lower borrowing costs, it increases precautionary motives to the economy, leading to more savings and less borrowing.

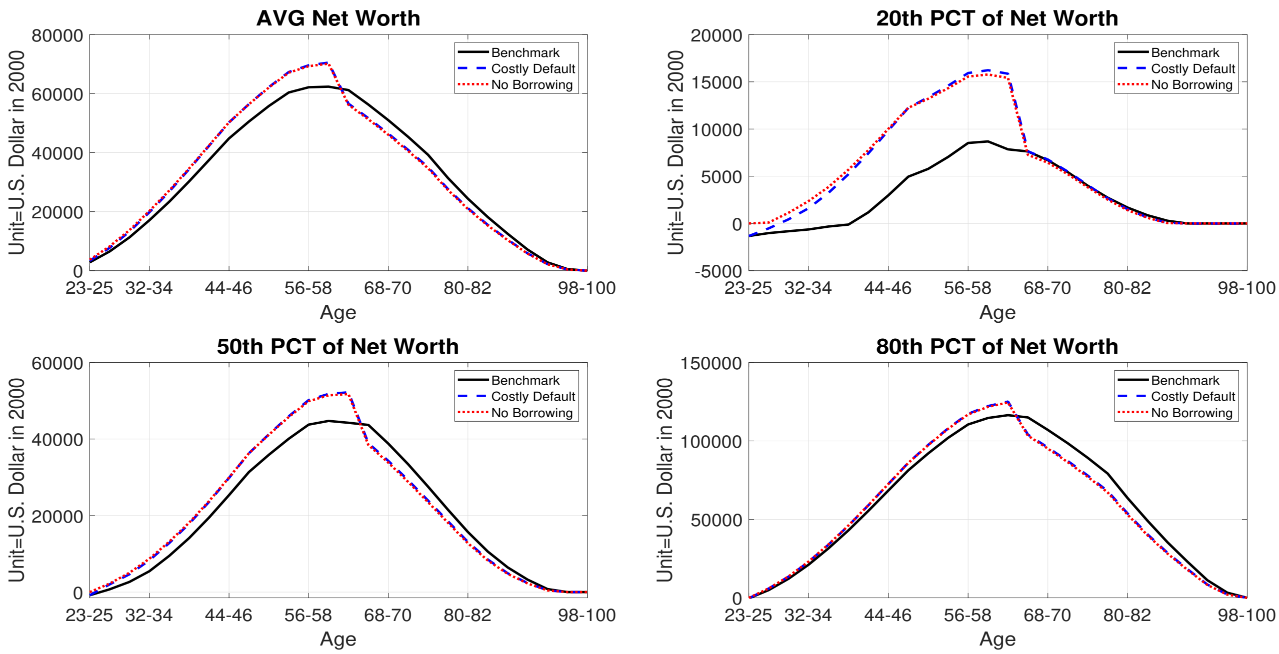

Figure 6: Effect of Strategic Default Option and Borrowing on Net Worth over the Life-cycle

Figure 6 also suggests that the availability of more access to credit plays a limited role, relative to that played by costly default, in accumulating assets over the life-cycle. Comparing the economy with costly default to that with no borrowing implies that the borrowing channel does not bring about a noticeable change in asset accumulation. Although low-wealth households show some differences in the early phase of the life-cycle, the gaps become smaller as households age. Note that although all households are allowed to take advantage of more accessible credit—lower borrowing costs—in the costly default case, most choose to borrow less and save more. These households' behaviors in accumulating assets imply that saving from additional precautionary motives against costly default dominates borrowing from more accessible credit, thereby increasing the aggregate capital, as shown in Table 13 in Appendix J.

Figure 7 shows changes in medical expenditures and health for households with a good credit history in the economy with costly default and no borrowing from their averages over all households in the benchmark economy.[23] As Figure 7 shows, given the extreme cost of default ("Costly Default"), households spend more on health during the working-age period, are healthier, and have

[23]I use this difference because in the economy with costly default and no borrowing, households with a bad credit history can hardly make any medical spending decisions. Recall that they get by with a meager income. When the extreme penalty of defaulting is introduced, households with a bad credit history show almost no spending on health, thereby just protracting extremely bad health over the life-cycle.

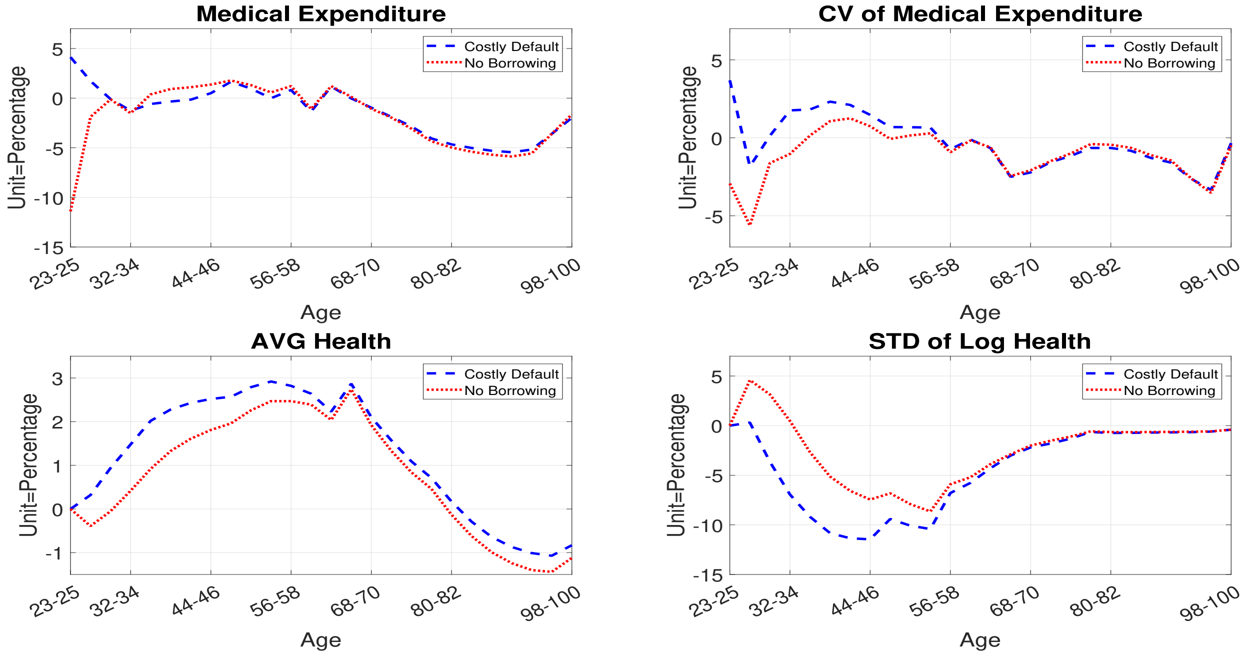

Figure 7: Changes in Medical Expenditure and Health (Good Credit History) from the Benchmark Economy

reduced health inequality. The left-top panel of Figure 7 shows that working-age households in the economy with costly default spend more on health than do those in the benchmark economy. The bottom panels of Figure 7 imply that these changes in medical spending behavior improve overall health and reduce health inequality. These findings suggest that additional precautionary savings against the costly default change households' medical spending behavior in a preventative manner; otherwise, health risks would become substantial financial burdens over the life-cycle.

Figure 7 also shows how the borrowing channel affects households' medical spending smoothing and the evolution of health. Figure 7 implies that their impacts are concentrated more on the early phase of the life-cycle. The top-left panel of Figure 7 suggests that the availability of more access to credit helps smooth medical spending especially for households in the very early phase of the life-cycle. The left-bottom panel of Figure 7 shows that this gap in medical spending causes differences in the evolution of health. In the economy with costly default, more accessible credit allows households to smooth spending on health, leading to improvements from the very early phase of the life-cycle. However, note that even without borrowing, households start increasing their medical spending during the working-age phase, thereby catching up on improvements in health and reducing health inequality. These findings imply that although the effects of borrowing are limited in the early phase of the life-cycle, the absence of the strategic default option gives households additional preventative medical spending motives, leading to improvements in health and a reduction in health inequality during the overall working-age period.

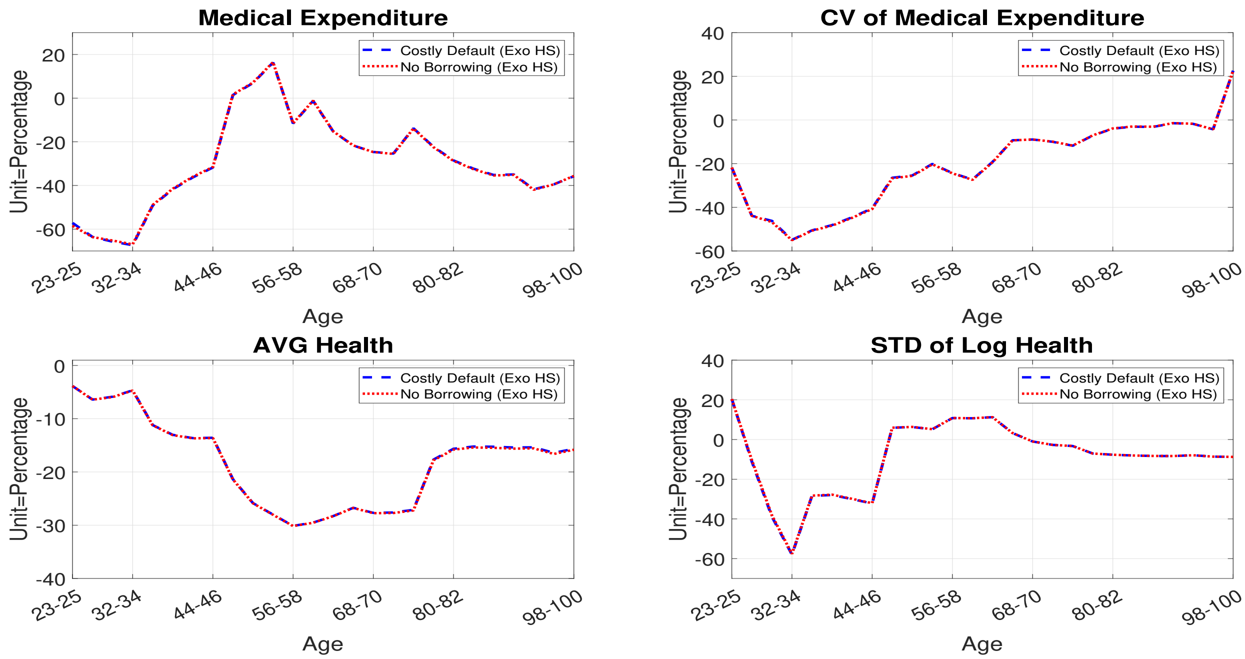

Figure 8: Changes in Medical Expenditure and Health (Good Credit History) from Endogenous to Exogenous Distribution of Health Shocks

Figure 8 shows changes in medical expenditures and health for those with the exogenous distribution of health shocks from the benchmark economy with the endogenous distribution of health shocks. Figure 8 shows that when the endogenous channel in the distribution of health shock is turned off, medical spending in those without the strategic default option is reduced, especially for young households. These findings imply that the increases in medical spending during the working-age period, observed in Figure 7, are substantially driven by households' preventative medical spending motives. When defaults are costly, through the adjusting of medical spending, households put more effort toward managing the evolution of health risks over the life cycle in a preemptive way.

These additional precautionary motives, which are caused by a lack of the strategic default option, also affect health insurance demand. Figure 9 shows that this increase in the take-up rate of IHI occurs mainly in the early phase of the life-cycle. These findings suggest that the extreme penalty causes additional precautionary motives; thereby, young households increase the demand for IHI. The take-up rate of Medicaid changes little because its exogenous policy rules are fixed. The demand for EHI also has a minor change because offered households tend to be included in the middle- and high-income groups; thus, they are less likely to be affected by precautionary motives. This increase in the demand for health insurance implies that the strategic default option reduces

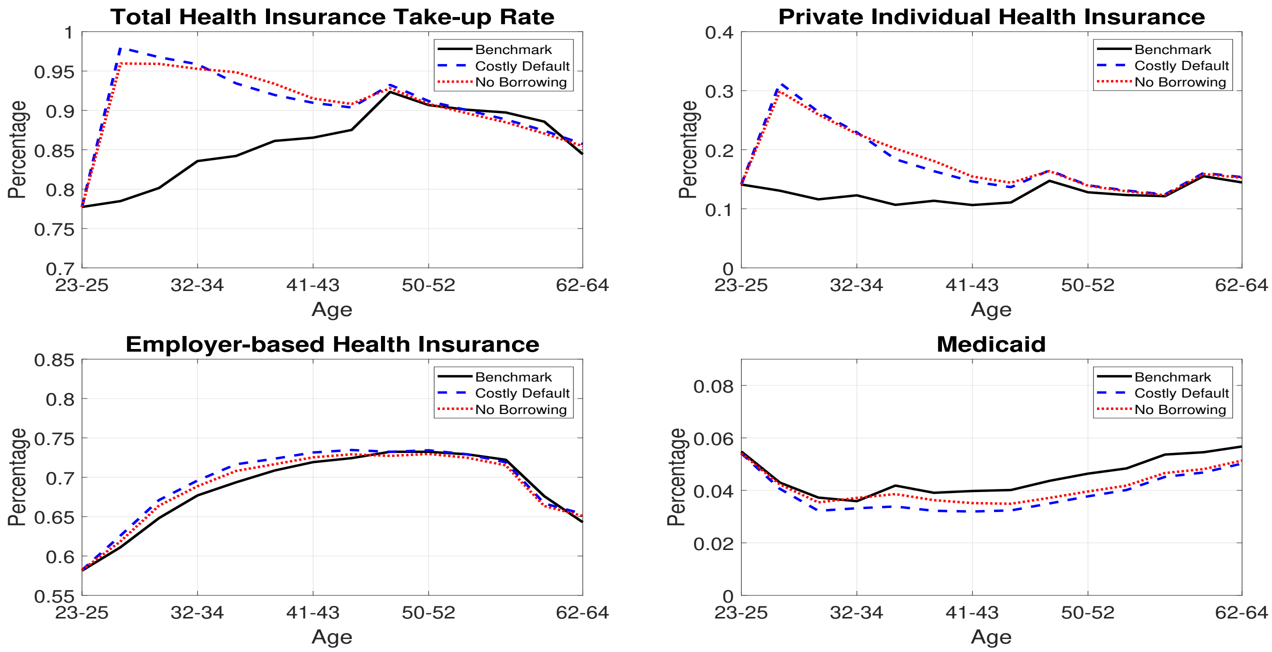

Figure 9: Effect of Strategic Default Option and Borrowing on Health Insurance over the Life-cycle

households' precautionary motives and acts as implicit health insurance by leading households to be reluctant to purchase health insurance, as noted in Mahoney (2015). When the strategic default option is unavailable, turning off the borrowing channel does not show a significant difference in the demand for IHI. Additionally, Figure 9 implies that the borrowing channel has no significant impact on health insurance demand.

Figure 10 shows the demand for health insurance over the life-cycle when the distributions of health shocks are exogenous. Figure 10 implies that in the benchmark economy, substantial health insurance demand is driven by motives for the managing of health risks, which means preventative healthcare motives. Without the endogenous channel of the distributions of health shocks, overall health insurance demands are reduced in the benchmark case, especially for young households. This reduction means that preventative motives in health drive a substantial portion of the health insurance demand in the benchmark economy. However, when the strategic default option is unavailable, such significant drops in the demand for health insurance do not occur because households retain health insurance to avoid the extreme penalty of defaulting (precautionary motives) rather than health reasons in the long-run. This disparity suggests that the motive for health insurance demand considerably differs according to whether the strategic default option is available.

In summary, the strategic default option interacts with preventative motives for medical spending, influencing the demand for health insurance and households' medical spending behaviors. When the strategic default option is unavailable, households have additional precautionary motives

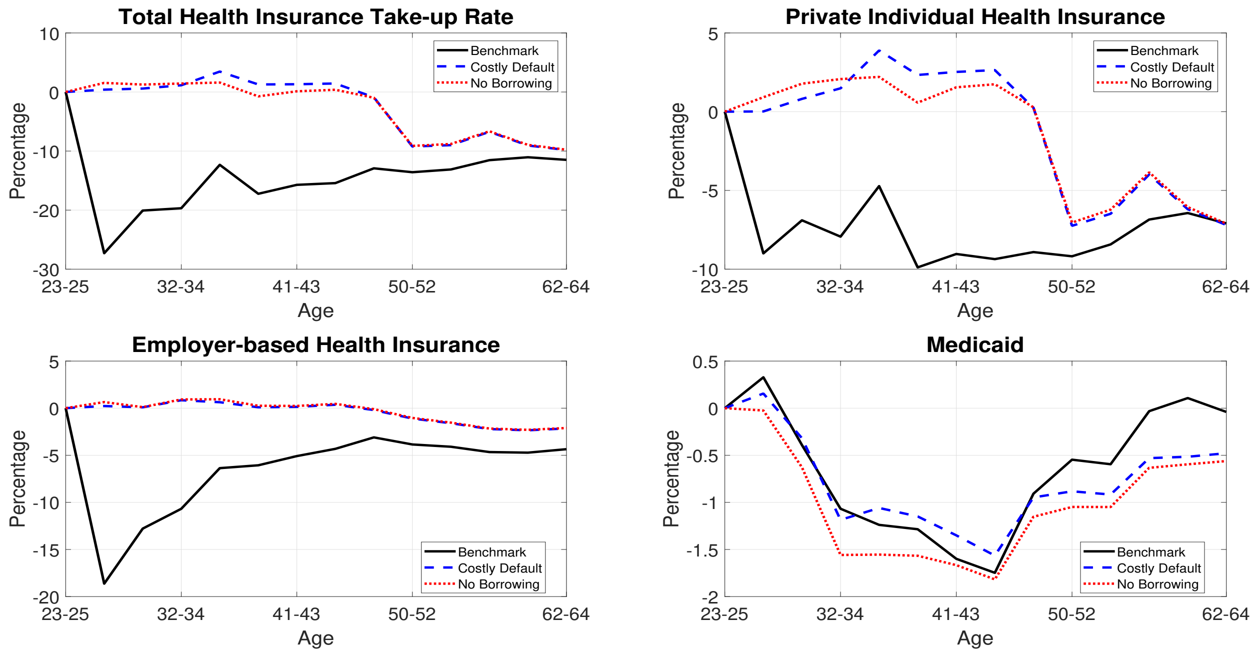

Figure 10: Changes in Health Insurance from the Endogenous to Exogenous Distribution of Health Shocks

in spending on health to avoid defaulting and visiting the ER, which imposes excessive financial costs over the life-cycle. Therefore, young households tend to increase their spending on health to facilitate the management of health risks. When this endogenous channel of the distribution of health shocks is shut down, households' medical spending behaviors do not show such increases for the working-age period in those without the strategic default option. Regarding health insurance, when defaults are costly, households are more likely to hold it to avoid the extreme financial cost of default, which is prolonged and amplified over the life-cycle. When default and ERs are easily accessible, as is the case with the benchmark economy, the substantial demand for health insurance is related to managing health risks in the long-run, rather than avoiding default. Given the importance of strategic default in explaining households' medical spending behavior and health insurance demand, I investigate how this channel plays a role in designing optimal health insurance policies in the following section.

4.2 Health Insurance Policy and Social Welfare Function

Regarding the optimal health insurance policy, I consider a reform of Medicaid (public health insurance for non-retirees) while preserving the system of the other types of health insurances, IHI and EHI. My objective here is to understand how much the strategic default option and the borrowing channel affect the extent to which the optimal health insurance policy is redistributive.

If various health insurance policies exist in the model with multiple types of health insurance, it is somewhat unclear how to represent the degree of redistributivness. Furthermore, there would be interactions among various health insurance policies, making it difficult to quantify what I am interested in.

Specifically, I seek the optimal level of the income threshold for Medicaid eligibility. The eligibility rule of Medicaid is given by

$$\Phi(y, i; \bar{M}, \bar{a}) = \begin{cases} 1 & \text{if } y \leq \bar{M} \text{ \& } a \leq \bar{a} \text{ \&} i = MCD \\ 0 & \text{otherwise} \end{cases} \tag{28}$$

where $\Phi(y, i; \bar{M}, \bar{a})$ is the proportion of the subsidy on the health insurance i premium given to households whose income is y. $\bar{M}$ is the income threshold for Medicaid eligibility, and $\bar{a}$ is the assets threshold for Medicaid eligibility. For example, if a household with $a < \bar{a}$ earns income lower than the income threshold for Medicaid eligiblity $\bar{M}$, it can use Medicaid.

An issue is that different healthcare reforms require different levels of tax revenues because the reforms are funded by taxes. I adjust τ_y of the income tax function, $a_0\{y-(y^{-a_1}+a_2)^{-1/a_1}\}+\tau_y\, y$, to balance the government budget while preserving the values of a_0, a_1, and a_2 in the baseline economy.

The government maximizes a social welfare function (SWF). The SWF values the ex-ante lifetime utility of an agent born into the stationary equilibrium implied by the chosen healthcare reform. The government solves

$$\left\{\bar{M}^*\right\} = \arg max_{\bar{M} \geq 0} SWF(\bar{M}) \tag{29}$$

$$\text{such that}$$

$$SWF(\bar{M}) = \int V^G_{j=23}(\mathbf{s}_0; \bar{M})\mu(d\mathbf{s}_0, j = 23; \bar{M}),$$

$$\mathbf{s}_0 = (a = 0, i = i_0, h = h_0, \epsilon_e, \epsilon_n, \eta, \zeta, \omega), \text{ and } (28).$$

where $V^G_{j=23}(\cdot; \bar{M})$ is the value of households at age 23 associated with $\bar{M}$, $\mu(\cdot; j = 23; \bar{M})$ is the distribution over households at age 23 associated with $\bar{M}$. Recall that all newborn households start with zero assets and the maximum level of health capital stock. The initial distribution of health insurance status is obtained from the MEPS by computing the joint distribution between earnings and health insurance status at age 23. I assume that the level of earnings in the MEPS reflects the level of labor productivity η. I assume that $(\epsilon_e, \epsilon_n, \eta, \zeta, \omega)$ are on their stationary distributions at age 23.[24]

I quantify welfare changes from the baseline economy by computing the consumption equivalent variation **CEV**, as in Pashchenko and Porapakkarm (2019).[25] First, I compute the ex-ante value at the initial age in the baseline and the experimental case, denoting them as V^B and V^E. Second, I provide a lump-sum transfer x to all households in the baseline economy and re-compute the value V^B. Third, I numerically find a level of the lump-sum transfer x that makes V^B equal to V^E. Finally, I represent the value of x as a percentage of the average consumption in each baseline economy.

4.3 Optimal Health Insurance Policies

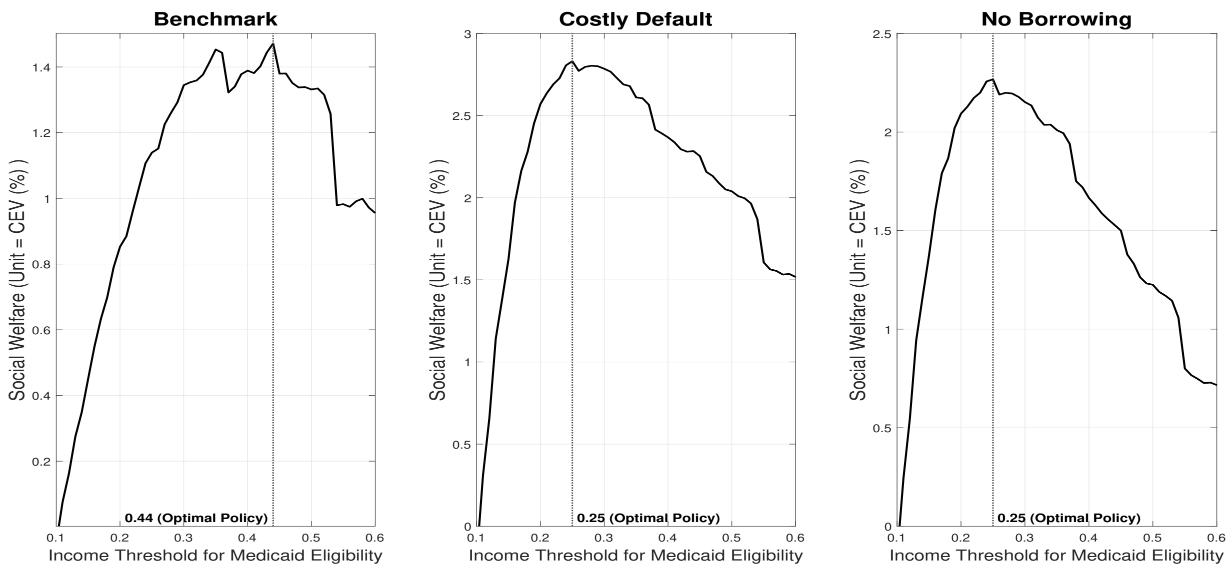

Figure 11: Social Welfare by the Strategic Default Option and Borrowing

Figure 11 shows social welfare changes (measured by the CEV) based on income thresholds for Medicaid eligibility $\bar{M}$ across the three economies. All three economies have a hump shape of welfare change because of the traditional trade-off between insurance and tax distortion. A notable feature is that given a policy change, welfare improves more in the economies with the extreme cost of defaulting ("Costly Default" and "No Borrowing") than in the benchmark economy. For example, when $\bar{M} = 0.2$ (approximately \$ 7286.6) in the benchmark economy, welfare improves as much as 0.83 percent in the benchmark economy, as much as 2.5 percent in the economy with

[24] I do not consider the asset testing for the eligibility of Medicaid in the reform, because, as mentioned previously, this channel does not work well in my model because of the lack of endogenous labor supply.

[25] Because the utility function is non-homothetic to consumption, I cannot compute changes in welfare, analytically using value functions.

costly default, and as much as 2.1 percent in the economy with no borrowing. These disparities take place because of differences in the magnitude of the welfare loss from defaulting. While defaulting is not that costly in the benchmark economy, it is extremely painful in the economy with costly default. By expanding Medicaid, more households in the costly default case can avoid mandatory defaults that involve vast penalties, experiencing substantial welfare improvements.

Figure 11 also shows that the optimal policy for Medicaid is the most redistributive in the benchmark economy. The optimal policy in the benchmark economy indicates that the income threshold for Medicaid eligibility $\bar{M}$ is 44 percent of the average income of the benchmark economy (approximately \$ 16,030). The optimal policy in the economy with costly default is less redistributive than that in the benchmark economy and the same as that in the economy with no borrowing: $\bar{M}$ is 25 percent of the average income of the benchmark economy (approximately \$ 9,108). These findings imply that the extreme cost of default is the main driving force behind the difference in the optimal policy for Medicaid. When the strategic default option is unavailable, more accessible credit has little role in determining the optimal policy for Medicaid.

A welfare change is determined by changes in consumption and health—the inputs of the utility function. Although the utility function, which is not homothetic with respect to consumption, makes it difficult to analytically decompose welfare changes into welfare variations because of consumption changes and those resulting from health, as in Conesa et al. (2009), investigating changes in consumption and health is still helpful for understanding these welfare results. Note that the monotonicity and concavity in the utility function imply that welfare improves when the level of inputs increases and their inequality is reduced.

Table 4: Changes in Health and Consumption from $M = 0.25$ to $M = 0.44$

Moment	Benchmark	Costly Default	No Borrowing
Strategic Default	O	X	X
Borrowing	O	O	X
AVG Health	$+0.357\%$	$+0.052\%$	$+0.052\%$
STD of Log Health	-1.096%	-0.031%	-0.097%
AVG Cons	-2.003%	-2.048%	-2.057%
STD of Log Cons	-1.450%	-1.127%	-1.193%
Welfare	$+0.33pp$	$-0.55pp$	$-0.74pp$

Table 4 shows changes in health, consumption, and welfare when the income threshold for Medicaid eligibility $\bar{M}$ is shifted from 0.25 to 0.44. Recall that $\bar{M} = 0.25$ is optimal in the economy with costly default and that $\bar{M} = 0.44$ is that in the benchmark economy. Thus, this comparison allows me to understand why the optimal policy is more redistributive when the strategic default is available. Comparing "Benchmark" with "Costly Default" implies that when strategic defaults are available (Benchmark), the change from $M = 0.25$ to $M = 0.44$ brings about greater improvements in health and a more substantial reduction in health inequality, thus improving welfare. An increase in the average health in the benchmark economy is greater than in the economy with costly default by 0.305 percentage points. Similarly, a reduction in the standard deviation of the log health in the benchmark economy is larger than in the economy with costly default by 1.065 percentage points. Further, this larger reduction in health inequality gives rise to a greater reduction in earnings inequality and, in turn, a decrease in consumption inequality, dampening the welfare loss from a reduction in the overall consumption caused by more distortions resulting from increased income taxes.

As noted by Table 4, in those without the strategic default option, expanding Medicaid more than the optimal level does not bring about such large health improvements. As can be seen in Figure 7, because medical spending is already substantially high to manage the evolution of health risks in the baseline health insurance system, there is little room for health enhancement by expanding Medicaid. In contrast, the benchmark economy has more margins for changing health. Additionally, as previously shown in Figure 10, in the benchmark economy, substantial health insurance demand is linked to motives to manage health risks over the life cycle. Therefore, expanding Medicaid facilities this management of health risks, especially for young and low-income households, thereby improving welfare through better health outcomes.

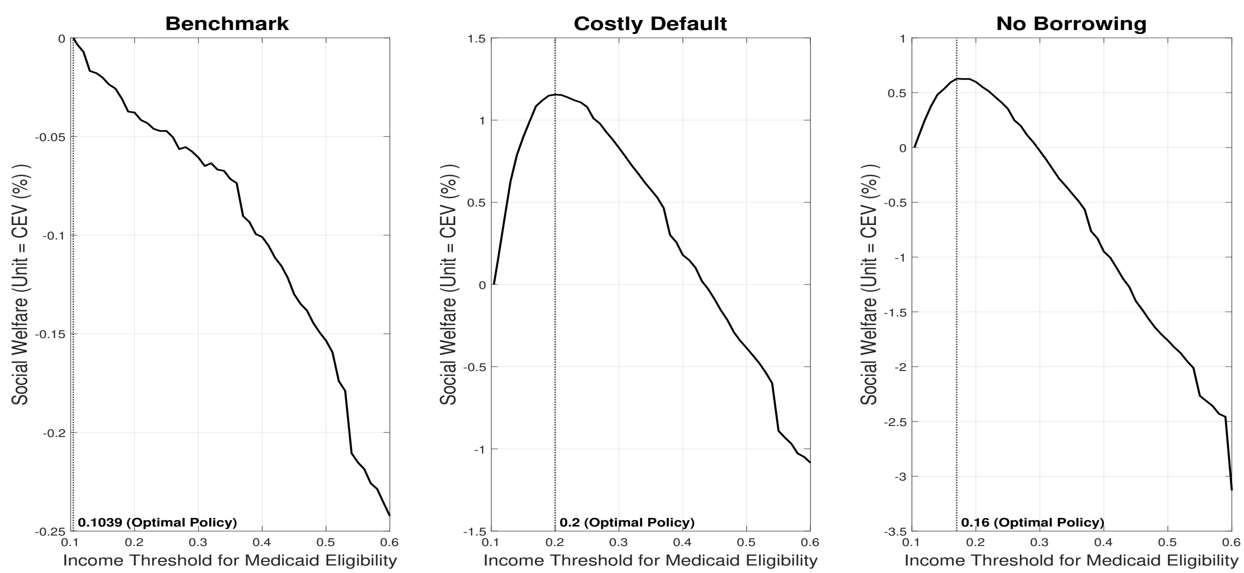

Figure 12: Social Welfare by the Strategic Default Option and Borrowing with Exogenous Distributions of Health Shocks

Figure 12 shows social welfare changes when the distributions of health shocks are exogenous. Figure 12 suggests that the preventative medical spending channel is important for the above welfare outcomes. When this preventative channel is turned off, the positive relationship between health insurance and the management of health risks does not exist, resulting in no expansion of Medicaid being optimal for the benchmark case. This finding implies that this health risk management channel is crucial for welfare improvements through better health outcomes in the benchmark economy. By contrast, when the strategic default option is unavailable, an expansion of Medicaid is still optimal, but to a lesser extent. Without the strategic default option, households demand health insurance to avoid the catastrophic cost of defaulting rather than to manage health risks over the life cycle. Therefore, even without the preventative medical spending channel, expanding Medicaid is still optimal for those without the strategic default option.

5 Conclusion

This paper explores how defaults and bankruptcies affect households' medical spending behaviors and health insurance demand, interacting with preventative healthcare. I build a life-cycle general equilibrium model in which agents have the strategic default option on their emergency medical bills and financial debts. They decide to invest in health capital and occasionally face emergency room events. Using micro and macro data, I calibrate the model based on the U.S. economy and use the model for the optimal health insurance policy.

I find that the strategic default option affects households' medical spending behaviors and demand for health insurance. Without the strategic default option, households tend to increase their spending on health for the working-age periods to avoid the extreme cost of default, the effects of which last and are amplified over the life-cycle. This increase in medical spending is largely driven by preventative motives for healthcare. Also, regarding household health insurance demand, preventative healthcare plays an important role. When defaults and bankruptcies are easily accessible as in the benchmark economy, a substantial portion of health insurance demand is shaped by preventative motives for healthcare. However, when defaults and bankruptcies are extremely costly as in those without the strategic default option, these preventative motives for healthcare play much less significant roles in shaping health insurance demand.

Because the interaction of the strategic default option with preventative motives for healthcare plays important roles in shaping households' medical spending behavior and health insurance demand, I investigate how they affect optimal health insurance by adjusting the income threshold for Medicaid eligibility.[26] I find that the strategic default option causes the optimal health insurance

[26]Over these exercises, I adjust the income threshold for Medicaid eligibility. Someone might think of finding the optimal bankruptcy policy because the default cost interacts with household medical spending behavior and health insurance demand. For example, when the default cost increases, while altering households' medical spending behavior and health insurance demand in a way to improve welfare, the deadweight loss from the increased default cost also becomes more remarkable, which plays a role in reducing welfare. I find that the effects of this increased deadweight loss are dominant to the countenancing forces related to medical spending and health insurance when determining welfare. The optimal bankruptcy policy is always not to give any penalty ($\xi = 0$).

to be more redistributive. With the strategic default option, the optimal Medicaid expansion is to cover households whose income is 44 percent of the average income; with no option to default, the optimal policy for Medicaid indicates the income threshold for eligibility to be 25 percent of the average income. Here the difference is accounted for by how much related the demand for health insurance is to preventative motives for healthcare. When the preventative channel for medical spending is turned off, the optimal policy in the benchmark economy is not to expand Medicaid.

The possibility exists that these results, driven mainly by precautionary motives, are overestimated because the model abstracts from endogenous labor supply. As shown in Wu and Krueger (2021), labor supply plays a substantial role as an insurance mechanism for individuals. Endogenous labor supply would weaken the insurance mechanism of default, thus potentially reducing the difference in the optimal policies by the strategic default option. This channel should be properly considered in future research. Additionally, elaborating on the insurance choice behavior of the elderly is essential. Here, health insurance policies for the elderly are simplified. Given the considerable effect of long-term care on aggregate savings, as shown in Kopecky and Koreshkova (2014), studying how long-term care interacts with financial risks is a meaningful task. Such analyses are deferred to future work.

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Online Appendix

Appendix A Charges from ER Events across Income Levels

Table 5: Charges from ER Events by Income Groups

Income	Average Charges of ER Events*
0-20 pct	2443.56
20-40 pct	2436.46
40-60 pct	2249.54
60-80 pct	2307.37
80-100 pct	2325.41

Source: author's calculation based on the MEPS 2000-2011
* Unit = U.S. Dollar in 2000

Table 6: Charges from ER Events by Age and Income Groups

	Average Charges for ER Events*					
Income	Age 23 - 34	Age 35 - 46	Age 47 - 55	Age 56 -64	Age 65 - 76	Age 77 - 91
0-20 pct	1992.87	2222.93	2549.63	3025.09	2616.33	3154.18
20-40 pct	2094.95	2066.45	2752.9	2820.07	2902.95	2657.69
40-60 pct	2030.77	2129.41	2603.14	2625.31	2112.71	2197.29
60-80 pct	2023.42	2244.27	2394.9	2582.79	2348.57	2607.37
80-100 pct	2209.8	2051.07	2577.25	2464.83	2687.7	2284.63

Source: author's calculation based on the MEPS
* Unit = U.S. Dollar in 2000

Table 7: Regression Result of the Log of ER Charges

	Only Income	Age and Income
log income	0.122 (0.144)	0.12(0.144)
age		0.005778 (0.004)

I run an OLS regression of the log of ER charges on the log of income and age.
The parentheses indicate p-values.

Table 5 shows that differences in the average charges from ER events are small across income levels. The maximum gap is smaller than 200 dollars. Table 6 also confirms that the result is still robust after controlling age groups. There is no monotonic relationship between income and the amount of charges for ER events across age groups. Lastly, Table 7 indicates that the correlation between the log of charges for the ER and the log of income is not statistically significant at the 10 percent level.

Appendix B Findings on Emergency Room Visits, Medical Conditions, and Bankruptcy

Table 8: Correlation Between Health Risks and Income

Moment	Value
Corr b.w. Medical Conditions and Income	-0.146^{*}
Corr b.w. Fraction of ER Visits and Income	-0.078^{*}

[*]: statistically significant at the 5 level.

Table 8 shows that both medical conditions quantified by health shocks and the fraction of emergency room visits are negatively correlated with income.[27] The correlation between medical conditions and income is -0.146, and the correlation of the fraction of emergency room visits and income is -0.078. This indicates that the level of health risks differs across income levels. Low-income individuals are more exposed to health shocks than high-income individuals, and the poor are more exposed to emergency medical events, which is an important channel for default on emergency medical bills through the EMTALA.

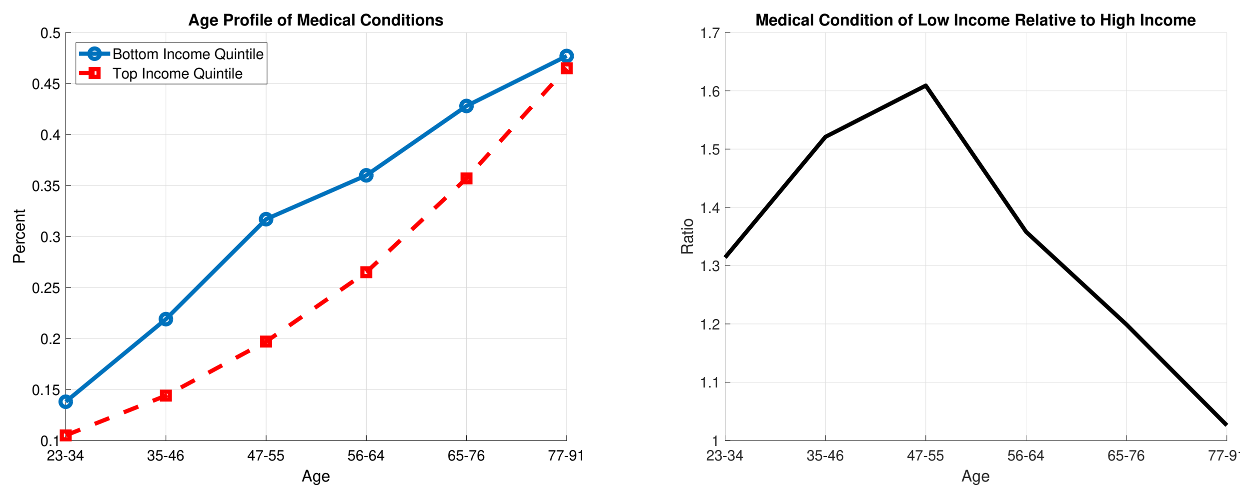


Figure 13: Age Profile of Medical Conditions

Figure 13 indicates the life-cycle profile of medical conditions quantified by health shocks between high-income individuals and low-income individuals. Differences in medical conditions across income groups are shown over the whole phase of life-cycle. The gap in medical conditions increases until age 55 and declines around retirement periods and the difference gets diminished

[27] Appendix H presents how medical conditions in the Medical Expenditure and Panel Survey (MEPS) are quantified in details.

and keeps declining until later life. The gap rapidly rises until age 55, and decreases around retirement periods and getting smaller in later life. The gap is large when households within an age group are revealed by more different healthcare circumstances. For example, old households have small differences, as their healthcare circumstance might be more similar than young households due to Medicare.

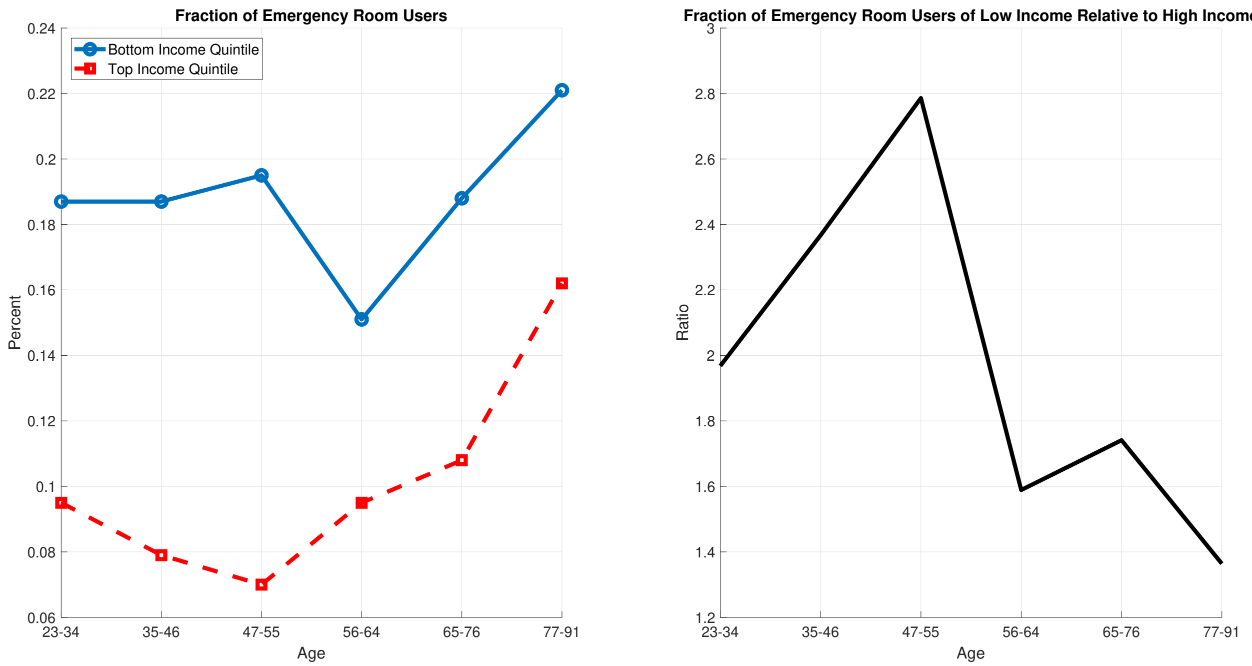


Figure 14: Age Profile of the Fraction of Emergency Room Visits

Figure 14 shows that the fraction of visiting emergency rooms between the top 20 percent income individuals and the bottom 20 percent income individuals over the life-cycle. Differences in emergency room visits across income groups appear over the whole phase of life-cycle. These gaps become disproportionately larger during the working-age period. This implies that during the working-age period, low-income individuals are more substantially exposed to emergency medical events, which may lead low-income individuals medical defaults through the EMTALA. Given that old households have more similar health-related circumstances due to Medicare, the gap is larger when households within an age group have more differences in their health-related circumstances.

Appendix C Household Dynamic Problems

The households' optimal decision problems can be represented recursively. I begin with the problems of working-age households. They start working at the initial age J_0 and continue working until age $J_r - 1$. The state of working-age households is $(a, i, h, \epsilon_e, \epsilon_n, \zeta, \eta, \omega)$ and $\upsilon \in \{G, B\}$, where a is their level of assets, i is health insurance, h is the stock of health capital, ϵ_e is emergency health shock, ϵ_n is non-emergency health shock, ζ is non-medical expense shocks, η is idiosyncratic shock on labor productivity and ω is the current offer status for employer-based health insurance. υ is the current credit history, where G and B mean good and bad credit history, respectively.

At the beginning of sub-period 1, emergency health shocks ϵ_e, non-emergency health shocks ϵ_n, non-medical expense shocks ζ, idiosyncratic shocks on earnings η, and the employer-based health insurance offer ω are realized. Next, individuals decide whether to default. Let $V_j^G(a, i, h, \epsilon_e, \epsilon_n, \zeta, \eta, \omega)$ ($V_j^B(a, i, h, \epsilon_e, \epsilon_n, \zeta, \eta, \omega)$) denote the value function of age $j < J_r$ agent with a good (bad) credit history in sub-period 1. They solve

$$V_j^G(a, i, h, \epsilon_e, \epsilon_n, \zeta, \eta, \omega) = \max \{v_j^{G,N}(a, i, h, \epsilon_e, \epsilon_n, \zeta, \eta, \omega), v_j^{G,D}(i, h, \epsilon_e, \epsilon_n, \eta, \omega)\} \tag{30}$$

$$V_j^B(a, i, h, \epsilon_e, \epsilon_n, \zeta, \eta, \omega) = \max \{v_j^{B,N}(a, i, h, \epsilon_e, \epsilon_n, \zeta, \eta, \omega), v_j^{B,D}(i, h, \epsilon_e, \epsilon_n, \eta, \omega)\} \tag{31}$$

where $v_j^{G,N}(a, i, h, \epsilon_e, \epsilon_n, \zeta, \eta, \omega)$ ($v_j^{B,N}(a, i, h, \epsilon_e, \epsilon_n, \zeta, \eta, \omega)$) is the value of non-defaulting with a good credit (bad credit) history and $v_j^{G,D}(i, h, \epsilon_e, \epsilon_n, \eta, \omega)$ ($v_j^{B,D}(i, h, \epsilon_e, \epsilon_n, \eta, \omega)$) is the value of defaulting with a good credit (bad credit) history. The values of defaulting, $v_j^{G,D}(i, h, \epsilon_e, \epsilon_n, \eta, \omega)$ and $v_j^{B,D}(i, h, \epsilon_e, \epsilon_n, \eta, \omega)$, do not depend on the current assets a, as all assets and debts are eliminated with the default decision, $a = 0$.

Non-defaulters with a good credit history at age $j < J_r$ in age group j_g solve

$$v_j^{G,N}(a,i,h,\epsilon_e,\epsilon_n,\eta,\zeta,\omega) = \max_{\{c,\,a',\,i',\,m_n\geq 0\}} \frac{\left[\left(\lambda_u c^{\frac{v-1}{v}} + (1-\lambda_u)h_c^{\frac{v-1}{v}}\right)^{\frac{v}{v-1}}\right]^{1-\sigma}}{1-\sigma} + B_u$$
$$+ \beta\pi_{j+1|j}(h_c,j_g) \mathop{\mathbb{E}}_{\epsilon_e'|h',\epsilon_n'|h',\eta'|\eta,\omega'|\eta',\zeta'} \left[V_{j+1}^G(a',i',h',\epsilon_e',\epsilon_n',\eta',\zeta',\omega')\right] \tag{32}$$

such that

$$c + q(a',i',h';j,\eta)a' + p_{i'}(h_c,j_g)$$
$$\leq (1-\tau_{ss}-\tau_{med})\,(w - c_{EHI}\cdot \mathbb{1}_{\omega=1})\,\bar{\omega}_j h_c^{\phi_h}\eta + a$$
$$-(1-q_i^n)\,m_n + (1-q_i^e)\,m_e(\epsilon_e) - \zeta - T(y) + \kappa$$

$$\zeta \sim U[0,\bar{\zeta}]$$
$$h_c = (1-\epsilon_n)(1-\epsilon_e)h$$
$$h' = h_c + \varphi_{j_g} m_n^{\psi_{j_g}} = (1-\epsilon_n)(1-\epsilon_e)h + \varphi_{j_g} m_n^{\psi_{j_g}}$$
$$i \in \{NHI, MCD, IHI, EHI\}$$
$$i' \in \begin{cases} \{NHI, MCD, IHI, EHI\} & \text{if } y \leq \bar{y} \ \&\ a \leq \bar{a} \ \&\ \omega = 1 \\ \{NHI, MCD, IHI\} & \text{if } y \leq \bar{y} \ \&\ a \leq \bar{a} \ \&\ \omega = 0 \\ \{NHI, IHI, EHI\} & \text{if } [y > \bar{y} \vee a > \bar{a}] \ \&\ \omega = 1 \\ \{NHI, IHI\} & \text{if } [y > \bar{y} \vee a > \bar{a}] \ \&\ \omega = 0 \end{cases}$$
$$y = (w - c_{EHI}\cdot \mathbb{1}_{\omega=1})\,\omega_j h_c^{\phi_h}\eta + (1-q^{rf})a\cdot \mathbb{1}_{a>0}$$
$$-(1-\psi_{EHI})\cdot p_{EHI}\cdot \mathbb{1}_{i'=EHI}.$$

where c is consumption, a' is asset holdings in the next period, i' is the purchase of health insurance for the next period, m_n is non-emergency medical expenditure, h_c is the current health status and β is the discount rate. $\pi_{j+1|j}(h_c,j_g)$ is the rate of surviving up to age $j+1$ condition on surviving up to age j with the current status of health h_c in age group j_g. $\mathbb{E}_{\epsilon_e'|h',\epsilon_n'|h',\eta'|\eta,\omega'|\eta',\zeta'}$ is an expectation that is taken to non-medical expense shocks ζ', (non-) emergency health shocks (ϵ_n') ϵ_e', idiosyncratic shocks on labor productivity η' and the offer probability of employer-based health insurance ω', conditional on the current idiosyncratic labor productivity η and health capital h' for the next period. $q(a',i',h';j,\eta)$ is the discount rate of loan for households with future endogenous state, (a',i',h'), conditional on the current idiosyncratic labor productivity, η and age j, and $p_{i'}(h_c,j_g)$ is the premium of health insurance i' for the next period given the current health status h_c and age group j_g. τ_{ss} and τ_{med} are payroll taxes for Social Security and Medicare, respectively. w is the market equilibrium wage, and c_{EHI} is the portion of wage deduction for workers receiving an offer of employer-based health insurance, and $\mathbb{1}_{a>0}$ is the indicator function for the offer of employer-based health insurance. $\bar{\omega}_j$ is age-deterministic labor productivity, ϕ_c is the elasticity of earnings with respect to current health status h_c, and η is idiosyncratic shock on labor productivity. q_i^n and q_i^e are the coverage rate of health insurance i for non-emergency and emergency medical expense, respectively. $m_e(\epsilon_e)$ is emergency medical expense, $T(\cdot)$ is income tax, y is total income, and κ is accidental bequest. NHI means no health insurance, MCD is Medicaid, IHI is private individual health insurance, EHI is employer-based health insurance, $\bar{y}$ is the threshold for Medicaid eligibility, ω is the current offer status for employer-based health insurance, q^{rf} is the discount rate of the risk-free bond, and $\mathbb{1}_{a>0}$ is the indicator function for savings. Thus, $(1-q^{rf})a$ means capital income.

I assume that some workers randomly get the opportunity to pool their health risks with others, which is EHI. They pay for it by deducting an amount c_{EHI} from the wage per effective labor unit w. The portion of this wage reduction c_{EHI} satisfies the following zero-profit condition:

$$c_{EHI} = \frac{\psi_{EHI} \cdot p_{EHI} \cdot \sum_{j=J_0}^{J_r-1} \int \mathbb{1}_{\{i=EHI\}} \mu(d\mathbf{s}, j)}{\sum_{j=J_0}^{J_r-1} \int [\mathbb{1}_{\{\omega=1\}} \cdot \bar{\omega}_j h_c^{\phi_h} \eta] \mu(d\mathbf{s}, j)} \tag{33}$$

where $\mu(\mathbf{s}, j)$ is the measure of households at age j of state **s**.

Note that the expectation is taken to emergency and non-emergency health shocks conditional on health capital h' for the next period, $\epsilon_e'|h'$ and $\epsilon_n'|h'$, as the distributions of these health shocks are determined by health capital h'. In addition, the probability of the offer for employer-based health insurance is conditional on idiosyncratic shocks on earnings η' in the next period, as the offer rate ω' increases with labor productivity level η'.

Non-defaulters with a good credit history have an endowment from their labor income $w\bar{\omega}_j h_c^{\phi_h}\eta$, their current assets a and accidental bequest κ. Then, these households access financial intermediary to either borrow $(a' < 0)$ at prices that reflect their default risk or save $(a' > 0)$ at the risk-free interest rate. Afterward, they make decisions on consumption c, the purchase of health insurance i' and non-emergency medical expenditures m_n. In turn, non-defaulters with a good credit history pay a health insurance premium $p_{i'}(h_c, j_g)$, an out-of-pocket medical expenditures $(1-q_i)(m_n + m_e(\epsilon_e))$, payroll taxes for Social Security and Medicaid $(\tau_{ss} + \tau_{med})(w - c_{EHI} \cdot \mathbb{1}_{\omega=1})\bar{\omega}_j h_c^{\phi_h}\eta$ and income tax $T(y)$ for income $y = (w - c_{EHI} \cdot \mathbb{1}_{\omega=1})\omega_j h_c^{\phi_h}\eta + (1-q^{rf})a \cdot \mathbb{1}_{a>0} - (1-\psi_{EHI}) \cdot p_{EHI} \cdot \mathbb{1}_{i'=EHI}$. They preserve the good credit history until the next period.

Defaulting households with a good credit history at age $j < J_r$ in age group j_g solve

$$v_j^{G,D}(i,h,\epsilon_e,\epsilon_n,\eta,\omega) = \max_{\{c,\, i',\, m_n \geq 0\}} \frac{\left[\left(\lambda_u c^{\frac{v-1}{v}} + (1-\lambda_u) h_c^{\frac{v-1}{v}}\right)^{\frac{v}{v-1}}\right]^{1-\sigma}}{1-\sigma} + B_u$$
$$+ \beta \pi_{j+1|j}(h_c, j_g) \mathop{\mathbb{E}}_{\epsilon_e'|h', \epsilon_n'|h', \eta'|\eta, \omega'|\eta', \zeta'} \left[V_{j+1}^B(0, i', h', \epsilon_e', \epsilon_n', \zeta', \eta', \omega')\right] \quad (34)$$

such that

$$c + p_{i'}(h_c, j_g)$$
$$= (1 - \tau_{ss} - \tau_{med})\left(w - c_{EHI} \cdot \mathbb{1}_{\omega=1}\right) \bar{\omega}_j h_c^{\phi_h} \eta - (1 - q_i^n) m_n - T(y) + \kappa$$

$$\zeta \sim U[0, \bar{\zeta}]$$
$$h_c = (1-\epsilon_n)(1-\epsilon_e)h$$
$$h' = h_c + \varphi_{j_g} m_n^{\psi_{j_g}} = (1-\epsilon_n)(1-\epsilon_e)h + \varphi_{j_g} m_n^{\psi_{j_g}}$$
$$i \in \{NHI, MCD, IHI, EHI\}$$
$$i' \in \begin{cases} \{NHI, MCD, IHI, EHI\} & \text{if } y \leq \bar{y} \text{ \& } a \leq \bar{a} \text{ \& } \omega = 1 \\ \{NHI, MCD, IHI\} & \text{if } y \leq \bar{y} \text{ \& } a \leq \bar{a} \text{ \& } \omega = 0 \\ \{NHI, IHI, EHI\} & \text{if } [y > \bar{y} \vee a > \bar{a}] \text{ \& } \omega = 1 \\ \{NHI, IHI\} & \text{if } [y > \bar{y} \vee a > \bar{a}] \text{ \& } \omega = 0 \end{cases}$$
$$y = \left(w - c_{EHI} \cdot \mathbb{1}_{\omega=1}\right) \omega_j h_c^{\phi_h} \eta - \left(1 - \psi_{EHI}\right) \cdot p_{EHI} \cdot \mathbb{1}_{i'=EHI}.$$

On their budget constraint, debts from the financial intermediaries a, and emergency medical expenditures $m_e(\epsilon_e)$ and non-medical expense shocks ζ do not appear, as these individuals default on these two types of unsecured debts. Defaulters can determine the level of consumption c, the purchase of health insurance for the next period i', and non-emergency medical expenditure m_n, while they can neither save nor dissave in this period. In turn, they pay a health insurance premium $p_{i'}(h_c, j_g)$, an out-of-pocket medical expenditures $(1 - q_i)m_n$, payroll taxes for Social Security and Medicaid $(\tau_{ss} + \tau_{med})(w - c_{EHI} \cdot \mathbb{1}_{\omega=1})\, \bar{\omega}_j h_c^{\phi_h} \eta$, and income tax $T(y)$ for $y = \left(w - c_{EHI} \cdot \mathbb{1}_{\omega=1}\right) \omega_j h_c^{\phi_h} \eta - \left(1 - \psi_{EHI}\right) \cdot p_{EHI} \cdot \mathbb{1}_{i'=EHI}$.

Non-defaulters with a bad credit history at age $j < J_r$ in age group j_g solve

$$v_j^{B,N}(a, i, h, \epsilon_e, \epsilon_n, \eta, \zeta, \omega) = \max_{\{c,\, a' \geq 0,\, i', m_n \geq 0\}} \frac{\left[\left(\lambda_u c^{\frac{v-1}{v}} + (1-\lambda_u) h_c^{\frac{v-1}{v}}\right)^{\frac{v}{v-1}}\right]^{1-\sigma}}{1-\sigma} + B_u \tag{35}$$
$$+ \beta \pi_{j+1|j}(h_c, j_g) \mathop{\mathbb{E}}_{\epsilon_e'|h', \epsilon_n'|h', \eta'|\eta, \omega'|\eta', \zeta'} \Big[\lambda V_{j+1}^G(a', i', h', \epsilon_e', \epsilon_n', \zeta', \eta', \omega')$$
$$+ (1-\lambda) V_{j+1}^B(a', i', h', \epsilon_e', \epsilon_n', \zeta', \eta', \omega')\Big]$$

such that

$$c + q^{rf} a' + p_{i'}(h_c, j_g)$$
$$\leq (1 - \tau_{ss} - \tau_{med})(1-\xi)\left(w - c_{EHI} \cdot \mathbb{1}_{\omega=1}\right) \bar{\omega}_j h_c^{\phi_h} \eta + a + \kappa$$
$$- (1 - q_i^n)\, m_n + (1 - q_i^e)\, m_e(\epsilon_e) - \zeta - T(y)$$

$$\zeta \sim U[0, \bar{\zeta}]$$
$$h_c = (1-\epsilon_n)(1-\epsilon_e) h$$
$$h' = h_c + \varphi_{j_g} m_n^{\psi_{j_g}} = (1-\epsilon_n)(1-\epsilon_e) h + \varphi_{j_g} m_n^{\psi_{j_g}}$$
$$i \in \{NHI, MCD, IHI, EHI\}$$
$$i' \in \begin{cases} \{NHI, MCD, IHI, EHI\} & \text{if } y \leq \bar{y} \;\&\; a \leq \bar{a} \;\&\; \omega = 1 \\ \{NHI, MCD, IHI\} & \text{if } y \leq \bar{y} \;\&\; a \leq \bar{a} \;\&\; \omega = 0 \\ \{NHI, IHI, EHI\} & \text{if } [y > \bar{y} \vee a > \bar{a}] \;\&\; \omega = 1 \\ \{NHI, IHI\} & \text{if } [y > \bar{y} \vee a > \bar{a}] \;\&\; \omega = 0 \end{cases}$$
$$y = \left(w - c_{EHI} \cdot \mathbb{1}_{\omega=1}\right) \omega_j h_c^{\phi_h} \eta + (1 - q^{rf}) a \cdot \mathbb{1}_{a>0}$$
$$- (1 - \psi_{EHI}) \cdot p_{EHI} \cdot \mathbb{1}_{i'=EHI}.$$

where λ is the probability of recovering their credit history to be good, and ξ is a proportion of earnings that is paid for the pecuniary cost of staying with a bad credit history. Although the problem of non-defaulters with bad credit is similar to that of non-defaulters with good credit, there are three differences between two problems. First, non-defaulters with bad credit are not allowed to borrow but they can save, $a' \geq 0$. Second, they need to pay the pecuniary cost of having a bad credit history as much as a fraction ξ of earnings, $\xi(w - c_{EHI} \cdot \mathbb{1}_{\omega=1})\, \bar{\omega}_j h_c^{\phi_h} \eta$. Lastly, the status of its credit history in the next period is not deterministic. With a probability of λ, the status of credit history for non-defaulters with a bad credit history changes to be good, and they stay with a bad credit history with a probability of $1 - \lambda$. This process reflects the exclusion penalty in Chapter 7

Bankruptcy of 10 years in the U.S.

Defaulters with a bad credit history at age $j < J_r$ in age group j_g solve

$$
\begin{aligned}
v_j^{B,D}(i,h,\epsilon_e,\epsilon_n,\eta,\omega) = & \max_{\{c,\, i',\, m_n \geq 0\}} \frac{\left[\left(\lambda_u c^{\frac{v-1}{v}} + (1-\lambda_u) h_c^{\frac{v-1}{v}}\right)^{\frac{v}{v-1}}\right]^{1-\sigma}}{1-\sigma} + B_u \\
& + \beta \pi_{j+1|j}(h_c, j_g) \underset{\epsilon_e'|h',\epsilon_n'|h',\eta'|\eta,\omega'|\eta',\zeta'}{\mathbb{E}} \left[V_{j+1}^B(0,i',h',\epsilon_e',\epsilon_n',\eta',\omega')\right] \qquad (36)
\end{aligned}
$$

such that

$$
\begin{aligned}
& c + p_{i'}(h_c, j_g) \\
& = (1-\tau_{ss}-\tau_{med})(1-\xi)\left(w - c_{EHI}\cdot \mathbb{1}_{\omega=1}\right)\bar{\omega}_j h_c^{\phi_h}\eta - (1-q_i^n)m_n - T(y) + \kappa \\
& \\
& \zeta \sim U[0,\bar{\zeta}] \\
& h_c = (1-\epsilon_n)(1-\epsilon_e)h \\
& h' = h_c + \varphi_{j_g} m_n^{\psi_{j_g}} = (1-\epsilon_n)(1-\epsilon_e)h + \varphi_{j_g} m_n^{\psi_{j_g}} \\
& i \in \{NHI, MCD, IHI, EHI\} \\
& i' \in \begin{cases} \{NHI, MCD, IHI, EHI\} & \text{if } y \leq \bar{y} \;\&\; a \leq \bar{a} \;\&\; \omega = 1 \\ \{NHI, MCD, IHI\} & \text{if } y \leq \bar{y} \;\&\; a \leq \bar{a} \;\&\; \omega = 0 \\ \{NHI, IHI, EHI\} & \text{if } [y > \bar{y} \vee a > \bar{a}] \;\&\; \omega = 1 \\ \{NHI, IHI\} & \text{if } [y > \bar{y} \vee a > \bar{a}] \;\&\; \omega = 0 \end{cases} \\
& y = \left(w - c_{EHI}\cdot \mathbb{1}_{\omega=1}\right)\omega_j h_c^{\phi_h}\eta - (1-\psi_{EHI})\cdot p_{EHI}\cdot \mathbb{1}_{i'=EHI}.
\end{aligned}
$$

The problem of defaulters with a bad credit history has two differences compared to the case of households with a good credit history. First, defaulters with a bad credit history have to pay the pecuniary cost of staying bad credit as much as a fraction ξ of their earnings, $\xi(w - c_{EHI}\cdot \mathbb{1}_{\omega=1})\,\bar{\omega}_j h_c^{\phi_h}\eta$. Second, they default only on emergency medical expenses and non-medical expense shocks. For defaulters with bad credit, their previous status is either non-defaulter with bad credit or defaulters with good credit. In both statuses, individuals could not make any financial loan in the previous period.

Retired households at age $J_r \leq j \leq \bar{J}$ in age group j_g solve

$$V_j^r(a, h, \epsilon_e, \epsilon_n, \zeta, y_{J_r-1}) = \max_{\{c,\, a' \geq 0,\, m_n \geq 0\}} \frac{\left[\left(\lambda_u c^{\frac{v-1}{v}} + (1-\lambda_u) h_c^{\frac{v-1}{v}}\right)^{\frac{v}{v-1}}\right]^{1-\sigma}}{1-\sigma} + B_u \tag{37}$$
$$+ \beta \pi_{j+1|j}(h_c, j_g) \mathop{\mathbb{E}}_{\epsilon_e'|h', \epsilon_n'|h', \zeta'} \left[V_{j+1}^r(a', h', \epsilon_e', \epsilon_n', \zeta', , y_{J_r-1})\right]$$

such that

$$\zeta \sim U[0, \bar{\zeta}]$$
$$c + q^{rf} a' + p_{med}$$
$$\leq ss(y_{J_r-1}) + a + \kappa - (1 - q^n_{med})\, m_n - (1 - q^e_{med})\, m_e(\epsilon_e) - \zeta - T(y)$$

$$h_c = (1-\epsilon_n)(1-\epsilon_e)h$$
$$h' = h_c + \varphi_{j_g} m_n^{\psi_{j_g}} = (1-\epsilon_n)(1-\epsilon_e)h + \varphi_{j_g} m_n^{\psi_{j_g}}$$
$$y = ss + (1 - q^{rf})a \cdot \mathbb{1}_{a>0}$$

where $ss(y_{J_r-1})$ is Social Security benefit with earnings at retirement age $J_r - 1$, p_{med} is the Medicare premium, and (q^e_{med}) q^n_{med} is the coverage rate of Medicare for (non-) emergency medical expenses. For simplicity, retired households cannot borrow, but they can save. I assume that retired households do not access private health insurance markets. Retired households do not have labor income, but receive Social Security benefit, ss, in each period. Thus, they pay income tax based on Social Security benefit ss and capital income $(1 - q^{rf})a \cdot \mathbb{1}_{a>0}$. Retired households do not pay payroll taxes, as they do have labor income. They do not have the option to default on ER bills and financial debts.

Appendix D Proof of proposition 2.7.1

Clausen and Strub (2017) introduce an envelope theorem to prove that First Order Conditions are necessary conditions for the global solution. They show that the envelop theorem is applicable to default models where idiosyncratic shocks on earnings are iid. I extend their application to solve this model, which has persistent idiosyncratic shocks on earnings. To use their envelope theorem, it is necessary to introduce the following definition.

Definition D.0.1. I say that $F : C \to \mathbb{R}$ is **differentiably sandwiched** between the lower and upper support functions $L, U : C \to \mathbb{R}$ at $\bar{c} \in C$ if

1. L is a differentiable lower support function of F at $\bar{c}$,i.e L is differentiable, $L(c) \leq F(c)$ for all $c \in C$, and $L(\bar{c}) = F(\bar{c})$.
2. U is a differentiable upper support function of F at $\bar{c}$,i.e U is differentiable, $U(c) \geq F(c)$ for all $c \in C$, and $U(\bar{c}) = F(\bar{c})$.

Let us begin with the FOC (17): For any $a^{'} > a_{rbl}(\bar{i}^{'}, \bar{h}^{'}; j, \eta)$

$$\frac{\partial q(a^{'}, \bar{i}^{'}, \bar{h}^{'}; j, \eta) a^{'}}{\partial a^{'}} \frac{\partial u(c, (1-\epsilon_e)(1-\epsilon_n)\bar{h})}{\partial c} = \frac{\partial W^G(a^{'}, \bar{i}^{'}, \bar{h}^{'}, \eta, j+1)}{\partial a^{'}}.$$

Lemma 2 (Maximum Lemma) and Lemma 3 (Reverse Calculus) in Clausen and Strub (2017) tell me that if each constituent function (q, u, W^G) of the FOC (17) has a differential lower support function at a point $a^{'}$, $q \times u$ and W^G are differentiable at $a^{'}$ and the FOC (17) is a necessary condition for the global solution.

Formally, **the proof of proposition 2.7.1** is as follows:

Proof. $u(\cdot, (1-\epsilon_e)(1-\epsilon_n)\bar{h})$ has trivially a differentiable lower support function, as itself is differentiable by the assumption. By lemma D.1 and lemma D.2, the discount rate of loan $q(\cdot, \bar{i}^{'}, \bar{h}^{'}; j, \eta)$ and the expected value function $W^G(\cdot, \bar{i}^{'}, \bar{h}^{'}, \eta, j+1)$ have a differentiable lower support function, respectively. That implies that each $u(\cdot, (1-\epsilon_e)(1-\epsilon_n)\bar{h})$, $q(\cdot, \bar{i}^{'}, \bar{h}^{'}; j, \eta)$ and $W^G(\cdot, \bar{i}^{'}, \bar{h}^{'}, \eta, j+1)$ has a differentiable lower support function. Lemma 3 (Reverse Calculus) in Clausen and Strub (2017) implies that the FOC (17) exists and holds. □

Lemma D.1. *Let a state $(\bar{i}^{'}, \bar{h}^{'}; j, \eta)$ be given. Let $a_{rbl}(\bar{i}^{'}, \bar{h}^{'}; j, \eta)$ be the risk borrowing limit (credit limit) of $q(\cdot, \bar{i}^{'}, \bar{h}^{'}; j, \eta)$. For all $a^{'} > a_{rbl}(\bar{i}^{'}, \bar{h}^{'}; j, \eta)$, the discount rate of loan $q(\cdot, \bar{i}^{'}, \bar{h}^{'}; j, \eta)$ has a differentiable lower support function.*

Proof. Case1: For any $a \geq 0$, $q(a^{'}, \bar{i}^{'}, \bar{h}^{'}; j, \eta) = \frac{1}{1+r^{rf}}$, and there by $\frac{\partial q(a^{'}, \bar{i}^{'}, \bar{h}^{'}; j, \eta) a^{'}}{\partial a^{'}} = 0$. Thus, $q(a^{'}, \bar{i}^{'}, \bar{h}^{'}; j, \eta)$ itself is a differentiable lower support function.

Case2: For any $a_{rbl}(\bar{i}', \bar{h}'; j, \eta) < a' < 0$, $q(a', \bar{i}', \bar{h}'; j, \eta) = \frac{1-d(a', \bar{i}', \bar{h}'; j, \eta)}{1+r^{rf}}$. It implies that finding a lower differentiable support function of $q(a', \bar{i}', \bar{h}'; j, \eta)$ is equivalent to doing a upper differentiable support function of

$d(a', \bar{i}', \bar{h}'; j, \eta) = \sum_{\epsilon_n', \epsilon_e', \eta', \omega'} \pi_{\epsilon_e'|h'} \pi_{\epsilon_n'|h'} \pi_{\eta'|\eta} \pi_{\omega'|\eta'} \mathbb{1}_{\{v^{G,N}(a', \mathbf{s_1'}, \eta', j+1) \leq v^{G,D}(\mathbf{s_1'}, \eta', j+1)\}}$

, where $\mathbf{s}_1' = (\bar{i}', \bar{h}', \epsilon_e', \epsilon_n', \omega')$. Let us transform $\pi_{\eta'|\eta}$ to a continuous PDF $f(\eta'|\eta)$. Given state $\mathbf{s}_1'$, let us denote $\delta(a', \eta; \mathbf{s_1'}) = \pi_{\epsilon_e'|\mathbf{h}'} \pi_{\epsilon_n'|\mathbf{h}'} \int \mathbb{1}_{\{\mathbf{v^{G,N}(a', s_1', \eta', j+1)} \leq \mathbf{v^{G,D}(s_1', \eta', j+1)}\}} \pi_{\omega'|\eta'} \mathbf{f}(\eta'|\eta) \mathbf{d}\eta'$. Since $a' > a_{rbl}(\bar{i}', \bar{h}'; j, \eta)$, $\{\eta' : v^{G,N}(a', \mathbf{s_1'}, \eta', j+1) \leq v^{G,D}(\mathbf{s_1'}, \eta', j+1)\}$ is non-empty. Theorem 3 (The Maximal Default Set Is a Closed Interval) and Theorem 4 (Maximal Default Set Expands with Indebtedness) in Chatterjee et al. (2007) imply that for any $a' > a_{rbl}(\bar{i}', \bar{h}'; j, \eta)$ and for each state $(\mathbf{s}_1', \eta', j+1)$, there are two points $\eta_1'(a'; \mathbf{s}_1', j+1)$ and $\eta_2'(a'; \mathbf{s}_1', j+1)$ such that (i) $\{\eta' : v^{G,N}(a', \mathbf{s_1'}, \eta', j+1) \leq v^{G,D}(\mathbf{s_1'}, \eta', j+1)\} = [\eta_1'(a'; \mathbf{s}_1', j+1), \eta_2'(a'; \mathbf{s}_1', j+1)]$ and (ii) for any $a' < a''$, $[\eta_1'(a'; \mathbf{s}_1', j+1), \eta_2'(a'; \mathbf{s}_1', j+1)] \subset [\eta_1'(a''; \mathbf{s}_1', j+1), \eta_2'(a''; \mathbf{s}_1', j+1)]$. The first property means

$\int_{\{\eta' : v^{G,N}(a', \mathbf{s_1'}, \eta', j+1) \leq v^{G,D}(\mathbf{s_1'}, \eta', j+1)\}} \pi_{\omega'|\eta'} f(\eta'|\eta) d\eta' = \int_{\eta' \in [\eta_1'(a'; \mathbf{s}_1', j+1), \eta_2'(a'; \mathbf{s}_1', j+1)]} \pi_{\omega'|\eta'} f(\eta'|\eta) d\eta'$

, and the second property implies that $\eta_1'(a'; \mathbf{s}_1', j+1)$ increases with a' and $\eta_2'(a'; \mathbf{s}_1', j+1)$ decreases with a'.

Since $\int_{\eta' \in [\eta_1'(a'; \mathbf{s}_1', j+1), \eta_2'(a'; \mathbf{s}_1', j+1)]} \pi_{\omega'|\eta'} f(\eta'|\eta) d\eta'$

$= \int_{-\infty}^{\eta_2'(a'; \mathbf{s}_1', j+1)} \pi_{\omega'|\eta'} f(\eta'|\eta) d\eta' - \int_{-\infty}^{\eta_1'(a'; \mathbf{s}_1', j+1)} \pi_{\omega'|\eta'} f(\eta'|\eta) d\eta'$, if there is an upper differentiable support of $\int_{-\infty}^{\eta_2'(a'; \mathbf{s}_1', j+1)} \pi_{\omega'|\eta'} f(\eta'|\eta) d\eta'$ and an lower differentiable support of

$\int_{-\infty}^{\eta_1'(a'; \mathbf{s}_1', j+1)} \pi_{\omega'|\eta'} f(\eta'|\eta) d\eta'$, $\delta(a', \eta; \mathbf{s_1'}) = \int_{\eta' \in [\eta_1'(\mathbf{a}'; \mathbf{s_1'}, \mathbf{j+1}), \eta_2'(\mathbf{a}'; \mathbf{s_1'}, \mathbf{j+1})]} \pi_{\omega'|\eta'} \mathbf{f}(\eta'|\eta) \mathbf{d}\eta'$ has a differentiable lower support. Without loss of generality, I will prove the existence of a differentiable upper support of

$\int_{-\infty}^{\eta_2'(a'; \mathbf{s}_1', j+1)} \pi_{\omega'|\eta'} f(\eta'|\eta) d\eta'$.

Claim: $\int_{-\infty}^{\eta_2'(a'; \mathbf{s}_1', j+1)} \pi_{\omega'|\eta'} f(\eta'|\eta) d\eta'$ has an upper differentiable support.

Proof of the claim: Finding an upper support function of $\int_{-\infty}^{\eta_2'(a'; \mathbf{s}_1', j+1)} \pi_{\omega'|\eta'} f(\eta'|\eta) d\eta'$ is equivalent to searching for an upper support function of $\eta_2'(a'; \mathbf{s}_1', j+1)$. I am going to use the implicit function theorem to find an upper differentiable support. Take any $\hat{a}' > a_{rbl}(\bar{i}', \bar{h}'; j, \eta)$ and $\eta' \in (\eta_1'(\hat{a}'; \mathbf{s}_1', j+1), \eta_2'(\hat{a}'; \mathbf{s}_1', j+1))$. Pick any $\epsilon_1 < \eta_2'(\hat{a}'; \mathbf{s}_1', j+1) - \eta_1'(\hat{a}'; \mathbf{s}_1', j+1)$. Consider a case that for a realized value $(a', \eta') \in B((\hat{a}', \eta_2'(a'; \mathbf{s}_1', j+1)), \epsilon)$, a household anticipates state $(a', \eta') = (a', \eta_2'(a'; \mathbf{s}_1', j+1))$. In other words, the household correctly recognizes a' but incorrectly acknowledges η'. Then, in the period after the next period, the decision rule for asset holdings is $a'' = g_a(a', \eta_2'(a'; \mathbf{s}_1', j+1)$. Define this borrower's net value function $L(a', \eta'; \hat{a}')$ on

$B((a^{'}, \eta_2^{'}(a^{'}; \mathbf{s}_1^{'}, j+1)), \epsilon)$ in the following way:

$$L(a^{'}, \eta^{'}; \hat{a}^{'}) = u\Big((w - c_{EHI} \cdot \mathbb{1}_{\omega=1})\, \bar{\omega}_j h_c \eta^{'} + a^{'} - (1-q_i)(m_n^{'} + m_e(\epsilon_e^{'})) \tag{38}$$
$$-T(y^{'}) + \kappa^{'} - q(g_a(a^{'}, \eta_2^{'}(a^{'} i^{''}, h^{''}; \eta_2^{'}(a^{'}; \mathbf{s}_1^{'}, j+1), j+1) g_a(a^{'} i^{''}, h^{''}, \eta_2^{'}(a^{'}; \mathbf{s}_1^{'}, j+1), j+1) - p_{i^{''}}, h_c^{'}\Big)$$
$$-u\Big((w - c_{EHI} \cdot \mathbb{1}_{\omega=1})\, \bar{\omega}_j h_c \eta^{'} - (1-q_i) m_n^{'} - T(y^{'}) + \kappa^{'} - p_{i^{''}}, h_c^{'}\Big)$$
$$+\beta \pi_{j+2|j+1}(h_c^{'}, j_g) \mathop{\mathbb{E}}_{\epsilon_e^{''}|h^{''}, \epsilon_n^{''}|h^{''}, \eta^{''}|\eta_2^{'}(a^{'} i^{''}, h^{''}), \omega^{''}|\eta^{''}} \Bigg[\Big[V^G(g_a(a^{'}, \eta_2^{'}(a^{'} i^{''}, h^{''}), \eta_2^{'}(a^{'}; \mathbf{s}_1^{'}, j+1)), i^{''}, h^{''}, \epsilon_e^{''}, \epsilon_n^{''}, \eta^{''}, \omega^{''}, j+2)\Big]$$
$$-\Big[V^B(0, \eta_2^{'}(a^{'}; \mathbf{s}_1^{'}, j+1)), i^{''}, h^{''}, \epsilon_e^{''}, \epsilon_n^{''}, \eta^{''}, \omega^{''}, j+2)\Big]\Bigg]$$

Note that the value function is continuous and differentiable on $B\left((\hat{a}^{'}, \eta_2^{'}(\hat{a}^{'}; \mathbf{s}_1^{'}, j+1)), \epsilon\right)$, as the utility function u is differentiable. Also, this value function is an implicit function for $a^{'}$ and $\eta^{'}$, and $L(\hat{a}^{'}, \eta_2^{'}(\hat{a}^{'}; \mathbf{s}_1^{'}, j+1)); \hat{a}^{'}) = 0$. The value function is differentiable with respect to $\eta^{'}$ and its value is non-zero (positive). Thus, the implicit function theorem implies that there is an open neighborhood U of $\hat{a}^{'}$ and an open neighborhood V of $\eta_2^{'}(\hat{a}^{'}; \mathbf{s}_1^{'}, j+1))$ such that $\bar{\eta}^{'} = \bar{\eta}^{'}(a^{'}, \hat{a}^{'})$ satisfies

$$L(a^{'}, \bar{\eta}^{'}(a^{'}, \hat{a}^{'}); \hat{a}^{'}) = 0$$

where $\bar{\eta}^{'} \in V$ and $a^{'} \in U$. Since this household overvalues repaying debt, $\bar{\eta}^{'}(\cdot, \hat{a}^{'})$ is an upper support of $\eta_2^{'}(\cdot; \mathbf{s}_1^{'}, j+1)$ at $\hat{a}^{'}$. Furthermore, the implicit function theorem implies that $\bar{\eta}^{'}(\cdot, \hat{a}^{'})$ is differentiable on U. Thus, $\bar{\eta}^{'}(\cdot, \hat{a}^{'})$ is an upper differentiable support function of $\eta_2^{'}(\cdot; \mathbf{s}_1^{'}, j+1)$ at $\hat{a}^{'}$. Since the statement holds for all $a^{'} > a_{rbl}(\bar{i}^{'}, \bar{h}^{'}; j, \eta)$, $\eta_2^{'}(a^{'}; \mathbf{s}_1^{'}, j+1)$ has an upper differentiable upper support for all $a^{'} > a_{rbl}(\bar{i}^{'}, \bar{h}^{'}; j, \eta)$. Therefore, the claim is proven. Q.E.D.

Since $\int_{-\infty}^{\eta_2^{'}(a^{'}; \mathbf{s}_1^{'}, j+1)} \pi_{\omega^{'}|\eta^{'}} f(\eta^{'}|\eta) d\eta^{'}$ has an upper differentiable support function,
$d(a^{'}, \bar{i}^{'}, \bar{h}^{'}; j, \eta) = \sum_{\epsilon_n^{'}, \epsilon_e^{'}, \eta^{'}, \omega^{'}} \pi_{\epsilon_e^{'}|h^{'}} \pi_{\epsilon_n^{'}|h^{'}} \int_{-\infty}^{\eta_2^{'}(a^{'}; \mathbf{s}_1^{'}, j+1)} \pi_{\omega^{'}|\eta^{'}} f(\eta^{'}|\eta) d\eta^{'}$ has an upper differentiable support function. □

Lemma D.2. *Let a state $(\bar{i}^{'}, \bar{h}^{'}; j, \eta)$ be given. Let $a_{rbl}(\bar{i}^{'}, \bar{h}^{'}; j, \eta)$ be the risk borrowing limit (credit limit) of $q(\cdot, \bar{i}^{'}, \bar{h}^{'}; j, \eta)$. For all $a^{'} > a_{rbl}(\bar{i}^{'}, \bar{h}^{'}; j, \eta)$, the expected value function $W^G(\cdot, \bar{i}^{'}, \bar{h}^{'}; \eta, j+1)$ has a differentiable lower support function.*

Proof. To ease notation, let us denote $\mathbf{s}_1^{'} = (\bar{i}^{'}, \bar{h}^{'}, \epsilon_e, \epsilon_n, \eta^{'}, \omega^{'})$
(i) Case 1: $\bar{a}^{'} > 0$.
In this case, the discount rate of loan becomes q^{rf}. I can use the standard technique of Benveniste and Scheinkman's theorem. Consider a case that for a realized value $(a^{'}, \eta^{'})$, a household takes $a^{''} = g_a(\bar{a}^{'}, \mathbf{s}_1^{'}, j+1)$ for all $a^{'}$ and $\eta^{'}$. Let us define this agent's net value function $L(a^{'}, \eta^{'}; \bar{a}^{'})$ in

the following way:

$$L^0(a^{'},\eta^{'};\bar{a}^{'},\mathbf{s}_1^{'}) = u\Big((w - c_{EHI}\cdot\mathbb{1}_{\omega=1})\,\bar{\omega}_j h_c\eta^{'} + a^{'} - (1-q_i)(m_n^{'} + m_e(\epsilon_e^{'})) - T(y^{'}) + \kappa^{'} - q^{rf} g_a(\bar{a}^{'},\mathbf{s}_1^{'},j+1) - p_{i^{''}}, h_c^{'}\Big) \tag{39}$$

$$+\beta\pi_{j+2|j+1}(h_c^{'},j_g)\mathop{\mathbb{E}}_{\epsilon_e^{''}|h^{''},\epsilon_n^{''}|h^{''},\eta^{''}|\eta^{'},\omega^{''}|\eta^{''}}\Big[V^G(g_a(\bar{a}^{'},\mathbf{s}_1^{'},j+1),i^{''},h^{''},\epsilon_e^{''},\epsilon_n^{''},\eta^{''},\omega^{''},j+2)\Big]$$

Since there is no debt, the agent does not default. Thus, $L^0(\bar{a}^{'},\eta^{'};\bar{a}^{'}) = V^G(\bar{a}^{'},\mathbf{s}_1^{'}) = v^{G,N}(\bar{a}^{'},\mathbf{s}_1^{'})$ and $L(a^{'},\eta^{'};\bar{a}^{'}) \leq V^G(a^{'},\mathbf{s}_1^{'})$ for all $a^{'} \geq 0$. Moreover, $L(a^{'},\eta^{'};\bar{a}^{'})$ is differentiable at $\bar{a}^{'}$. Therefore, $L(\cdot,\eta^{'};\bar{a}^{'})$ is a lower differentiable support function of $V^G(\bar{a}^{'},\mathbf{s}_1^{'})$.
(ii) Case2: $a_{rbl}(\bar{i}^{'},\bar{h}^{'};j,\eta) < \bar{a}^{'} < 0$.
Let us consider a case for realized value $(a^{'},\eta^{'})$, a household takes $a^{''} = g_a(\bar{a}^{'},\mathbf{s}_1^{'},j+1)$ for all $a^{'}$ and $\eta^{'}$. Let us define this agent's net value function $L^1(a^{'},\eta^{'};\bar{a}^{'})$ in the following way:

$$\begin{aligned} L^1(a^{'},\eta^{'};\bar{a}^{'},\mathbf{s}_1^{'}) = \max\Big\{ & u\Big((w - c_{EHI}\cdot\mathbb{1}_{\omega=1})\,\bar{\omega}_j h_c\eta^{'} + a^{'} - (1-q_i)(m_n^{'} + m_e(\epsilon_e^{'})) \\ & -T(y^{'}) + \kappa^{'} - q - q(g_a(a^{'},\mathbf{s}_1^{'},j+1),i^{''},h^{''};\eta^{'},j+1)g_a(a^{'},\mathbf{s}_1^{'},j+1) - p_{i^{''}}, h_c^{'}\Big) \\ & +\beta\pi_{j+2|j+1}(h_c^{'},j_g)\mathop{\mathbb{E}}_{\epsilon_e^{''}|h^{''},\epsilon_n^{''}|h^{''},\eta^{''}|\eta^{'},\omega^{''}|\eta^{''}}\Big[V^G(g_a(\bar{a}^{'},\mathbf{s}_1^{'},j+1),i^{''},h^{''},\epsilon_e^{''},\epsilon_n^{''},\eta^{''},\omega^{''},j+2)\Big], \\ & u\Big((w - c_{EHI}\cdot\mathbb{1}_{\omega=1})\,\bar{\omega}_j h_c\eta^{'} - (1-q_i)m_n^{'} - T(y^{'}) + \kappa^{'} - p_{i^{''}}, h_c^{'}\Big) \\ & +\beta\pi_{j+2|j+1}(h_c^{'},j_g)\mathop{\mathbb{E}}_{\epsilon_e^{''}|h^{''},\epsilon_n^{''}|h^{''},\eta^{''}|\eta^{'},\omega^{''}|\eta^{''}}\Big[V^B(0,i^{''},h^{''},\epsilon_e^{''},\epsilon_n^{''},\eta^{''},\omega^{''},j+2)\Big]\Big\} \end{aligned} \tag{40}$$

$L^1(\bar{a}^{'},\eta^{'};\bar{a}^{'}) = V^G(\bar{a}^{'},\mathbf{s}_1^{'})$ and $L^1(a^{'},\eta^{'};\bar{a}^{'}) \leq V^G(a^{'},\mathbf{s}_1^{'})$ for all $a^{'} \geq 0$. Moreover, $L(a^{'},\eta^{'};\bar{a}^{'})$ is differentiable with respect to $a^{'}$. Therefore, $L^1(\cdot,\eta^{'};\bar{a}^{'})$ is a lower differentiable support function of $V^G(\bar{a}^{'},\mathbf{s}_1^{'})$.

□

Appendix E Recursive Equilibrium

I define a measure space to describe equilibrium. To ease notation, I denote $\mathbf{S} = \mathbf{A} \times \mathbf{I} \times \mathbf{H} \times \mathbf{ER} \times \mathbf{NER} \times \mathbf{E} \times \mathbf{O} \times \Upsilon$ as the state space of households, where $\mathbf{A}$ is the space of households' assets a, $\mathbf{I}$ is the space of households' health insurance i, $\mathbf{H}$ is the space of households' health capital h, $\mathbf{ER}$ is the space of emergency health shocks ϵ_e, $\mathbf{NER}$ is the space of non-emergency health shocks ϵ_n, $\mathbf{O}$ is the space of the offer of employer-based health insurance ω and Υ is the space of credit history $\upsilon \in \{G, B\}$. In addition, let $\mathbb{B}(\mathbf{S})$ denote the Borel σ-algebra on $\mathbf{S}$. In addition, I denote $\mathbf{J} = \{J_0, \cdots, J_r, \cdots, \bar{J}\}$ as the space of households' age. Then, for each age j, a probability measure $\mu(\cdot, j)$ is defined on the Borel σ-algebra $\mathbb{B}(\mathbf{S})$ such that $\mu(\cdot, j) : \mathbb{B}(\mathbf{S}) \longrightarrow [0, 1]$. $\mu(B, j)$ represents the measure of age j households whose state lies in $B \in \mathbb{B}(\mathbf{S})$ as a proportion of all age j. The households' distribution at age j in age group j_g evolves as follows: For all $B \in \mathbb{B}(\mathbf{S})$,

$$\mu(B, j+1) = \int_{\left\{\mathbf{s} | \left(g_a(\mathbf{s},j), g_i(\mathbf{s},j), g_h(\mathbf{s},j), \epsilon_e', \epsilon_n', \eta', \omega', \upsilon'\right) \in B\right\}} \left[\Gamma_{\upsilon}^{\upsilon'} \ \pi_{j+1|j}(h_c, j_g) \ \pi_{\epsilon_e'|g_h(\mathbf{s},j)} \ \pi_{\epsilon_n'|g_h(\mathbf{s},j)} \ \pi_{\eta'|\eta} \ \pi_{\omega'|\eta'}\right] \ \mu(d\mathbf{s}, j) \tag{41}$$

where $\mathbf{s} = (a, i, h, \epsilon_e, \epsilon_n, \eta, \omega, \upsilon) \in \mathbf{S}$ is the individual state. $g_a(\cdot, j)$ is the policy function for assets at age j, $g_i(\cdot, j)$ is the policy function for health insurance at age j, and $g_h(\cdot, j)$ is the policy function for health investment at age j. In addition, $\Gamma_{\upsilon}^{\upsilon'}$ is the transitional probability of credit history υ' in the next period conditional on the current status of credit history υ, $\pi_{j+1|j}(h_c, j_g)$ is the rate of surviving up to age $j+1$ conditional on surviving up to age j with the current health status h_c in age group j_g and $\pi_{\epsilon_e'|g_h(\mathbf{s},j)}$ ($\pi_{\epsilon_n'|g_h(\mathbf{s},j)}$) is the transition probability for ϵ_e' (ϵ_n') conditional on $g_h(\mathbf{s}, j)$. $\pi_{\eta'|\eta}$ is the transitional probability of idiosyncratic labor productivity for the next period η' conditional on η and $\pi_{\omega'|\eta'}$ is the probability of receiving an employer-based health insurance offer ω' for the next period conditional on η'.

Definition E.0.1 (***Recursive Competitive Equilibrium***)**.** Given an distribution of newborn agents $B_0 \in \mathbf{S}$, a social Security benefit $ss(\cdot)$, a Medicare coverage rate q_{med}, a Medicare premium p_{med}, a subsidy rule for employer-based health insurance ψ_{EHI}, mark-ups of health private insurances ν_{IHI} and ν_{EHI}, an income threshold for Medicaid eligibility $\bar{y}$, an asset test limit of Medicaid eligibility $\bar{a}$, health insurance coverage rates $\{(q^e_{MDC}, q^n_{MDC}), (q^e_{IHI}, q^n_{IHI}), (q^e_{EHI}, q^n_{EHI})\}$, private individual health insurance pricing rules $\{p_{IHI}(\cdot, j_g)\}_{j_g=1}^4$, subsidies for private individual health insurances $\psi_{EHI}(\cdot, \cdot)$, a tax policy, $\{T(\cdot), \tau_{ss}, \tau_{med}\}$,
a recursive competitive equilibrium is
a set of prices $\left\{w, r^{rf}, r, q^{rf}, \{q(\cdot, \cdot, \cdot, j, \cdot)\}_{j=J_0}^{J_r-1}, \{p(\cdot, j_g)\}_{j_g=1}^4, p_{med}\right\}$
, the portion of wage reduction for workers receiving an offer of employer-based health insurance $\{c_{EHI}\}$

, the mark-up of hospital $\{\Lambda\}$
, a set of decision rules for households $\left\{\{g_d(\cdot,j), g_a(\cdot,j), g_i(\cdot,j), g_h(\cdot,j)\}_{j=J_0}^{\bar{J}}\right\}$
, a set of default probability function $\left\{d(\cdot,\cdot,\cdot;j,\cdot)\}_{j=J_0}^{\bar{J}}\right\}$
, a set of values $\Bigg\{ \left\{V^G(\cdot,j), v^{G,N}(\cdot,j), v^{G,D}(\cdot,j), V^B(\cdot,j), v^{B,N}(\cdot,j), v^{B,D}(\cdot,j)\right\}_{j=J_0}^{J_r-1},$
$\left\{v^{G,r}(\cdot,j), v^{B,r}(\cdot,j)\right\}_{j=J_r}^{\bar{J}} \Bigg\}$
and distributions of households $\{\mu(\cdot,j)\}_{j=J_0}^{\bar{J}}$ such that

(i) Given prices, the policies above, the decision rules $g_d(\mathbf{s},j), g_a(\mathbf{s},j), g_i(\mathbf{s},j)$ and $g_h(\mathbf{s},j)$ solve the household problems in Appendix C and $V^G(\cdot,j), v^{G,N}(\cdot,j), v^{G,D}(\cdot,j), V^B(\cdot,j)$, $v^{B,N}(\cdot,j), v^{B,D}(\cdot,j), v^{G,r}(\cdot,j)$ and $v^{B,r}(\cdot,j)$ are the associated value functions.

(ii) There are two firms that act in a competitive manner. The first offers employer-based health insurance, but the second does not. They are competitive pricing:

$$w = \frac{\partial zF(K,N)}{\partial N}, \quad r = \frac{\partial zF(K,N)}{\partial K}$$

where K is the quantity of aggregate capital, and N is the quantity of aggregate labor.

(iii) Loan prices and default probabilities are consistent, whereby lenders earn zero expected profits on each loan of size $a^{'}$ for households with age j that have health insurance $i^{'}$ for the next period, health capital $h^{'}$ for the next period and the current idiosyncratic shock on earnings η:

$$\begin{aligned} q(a^{'},i^{'},h^{'};j,\eta) &= \frac{(1-d(a^{'},i^{'},h^{'};j,\eta))}{1+r^{rf}} \\ d(a^{'},i^{'},h^{'};j,\eta) &= \sum_{\epsilon_n^{'},\epsilon_e^{'},\eta^{'},\omega^{'}} \pi_{\epsilon_e^{'}|h^{'}}\pi_{\epsilon_n^{'}|h^{'}}\pi_{\eta^{'}|\eta}\pi_{\omega^{'}|\eta^{'}}\mathbb{1}_{\{v^{G,N}(\mathbf{s}_n^{'},j+1)\,\leq\, v^{G,D}(\mathbf{s}_d^{'},j+1)\}} \end{aligned}$$

where $s_n^{'} = (a^{'},i^{'},h^{'},\epsilon_e^{'},\epsilon_n^{'},\eta^{'},\omega^{'},j+1)$ and $s_d^{'} = (i^{'},h^{'},\epsilon_e^{'},\epsilon_n^{'},\eta^{'},\omega^{'},j+1)$.

(iv) The hospital has zero-profit:

$$\sum_{j=J_0}^{\bar{J}} \int \Bigg\{ [m_n(\mathbf{s},j) + (1-g_d(\mathbf{s},j))m_e(\epsilon_e) + g_d(\mathbf{s},j)\max(a,0)] - \frac{(m_n(\mathbf{s},j)+m_e(\epsilon_e))}{\zeta} \Bigg\} \mu(d\mathbf{s},j) = 0.$$

(v) The bond market and the capital market are clear:

$$
\begin{aligned}
r^{rf} &= r - \delta \\
q^{rf} &= \frac{1}{1 + r^{rf}} \\
K &= \sum_{j=J_0}^{\bar{J}} \Bigg[\int \Big(q(g_a(\mathbf{s}, j), g_i(\mathbf{s}, j), g_h(\mathbf{s}, j); j, \eta) g_a(\mathbf{s}, j) \\
&\quad + (p(g_i, h_c, j_g) \cdot \mathbb{1}_{\{g_i(\mathbf{s},j) \in \{IHI, EHI\}\}} \Big) \mu(d\mathbf{s}, j) \Bigg].
\end{aligned}
$$

(vi) The labor market is clear:

$$
N = \sum_{j=J_0}^{J_r - 1} \left[\bar{\omega}_j \int \left((1 - \epsilon_e)(1 - \epsilon_n) h \eta \right) \mu(d\mathbf{s}, j) \right].
$$

(vii) The goods market is clear:

$$
\begin{aligned}
&\underbrace{\sum_{j=J_0}^{\bar{J}} \left[\int \left(c(\mathbf{s}, j) + \frac{m_n(\mathbf{s}, j) + m_e(\epsilon_e)}{\zeta} \right) \mu(d\mathbf{s}, j) \right]}_{\text{Aggregate Non-medical Consumption + Aggregate Medical Expenditures}} + \underbrace{K - (1 - \delta) K}_{\text{Aggregate Investment}} + \underbrace{G}_{\text{Government Spending}} \\
&= \underbrace{zF(K, N)}_{\text{Total Output}} - \underbrace{\xi w \sum_{j=J_0}^{J_r - 1} \left[\bar{\omega}_j \int \left((1 - \epsilon_e)(1 - \epsilon_n) h_c g_d(\mathbf{s}, j) \right) \mu(d\mathbf{s}, j) \right]}_{\text{Deadweight Loss from Bad Credit History}} \\
&\quad - \underbrace{\sum_{j=J_0}^{J_r - 1} \left[\int \left(\nu_{g_i} p_{g_i}(h_c, j_g) \mathbb{1}_{\{g_i(\mathbf{s},j) \in \{IHI, EHI\}\}} \right) \mu(d\mathbf{s}, j) \right]}_{\text{Deadweight Loss due to the Mark-up of Private Health Insurance Markets}}.
\end{aligned}
$$

(viii) The insurance markets are clear:

For each age group j_g and each health group h_g, the premium of the private individual health insurance $p_{IHI}(h_g, j_g)$ satisfies

$$\underbrace{(1+\nu_{IHI})}_{\text{Mark-up of IHI}} \underbrace{\sum_{j\in J_g} \int q_{IHI} \cdot \mathbb{1}_{\{\{i=IHI\}\cap\{h\in h_g\}\}} \cdot (m_n(\mathbf{s}, j) + m_e(\epsilon_{e,t}))\mu(d\mathbf{s}, j)}_{\text{Total Medical Expenditure Covered by IHI}}$$
$$= (1+r^{rf})\, p_{IHI}(h_g, j_g) \underbrace{\sum_{j\in J_g} \int \mathbb{1}_{\{\{g_i(\mathbf{s},j)=IHI\}\cap\{h\in h_g\}\}}\mu(d\mathbf{s}, j)}_{\text{Total Demand for IHI}}.$$

The premium of the employer-based health Insurance p_{EHI} satisfies

$$\underbrace{(1+\nu_{EHI})}_{\text{Mark-up of EHI}} \underbrace{\sum_{j=J_0}^{J_r-1} \int q_{EHI} \cdot \mathbb{1}_{\{i=EHI\}}(m_n(\mathbf{s}, j) + m_e(\epsilon_e))\mu(d\mathbf{s}, j)}_{\text{Total Medical Expenditure Covered by EHI}}$$
$$= (1+r^{rf}) \cdot p_{EHI} \cdot \underbrace{\sum_{j=J_0}^{J_r-1} \int \mathbb{1}_{\{g_i(\mathbf{s},j)=EHI\}}\mu(d\mathbf{s}, j)}_{\text{Total Demand for EHI}}.$$

(ix) The government runs a balanced budget:

$$\sum_{j=J_r}^{\bar{J}} \int \Big[ss(y_{J_r-1}) + q^n_{med} \cdot m_n(\mathbf{s}, j) + q^e_{med} \cdot m_e(\epsilon_e) - p_{med}\Big]\mu(d\mathbf{s}, j)$$
$$+ \sum_{j=J_0}^{J_r-1} \int \Big[\Big(q^n_{MCD} \cdot m_n(\mathbf{s}, j) + q^e_{MCD} \cdot m_e(\epsilon_e)\Big) \cdot \mathbb{1}_{\{i=MCD\}}\Big]\mu(d\mathbf{s}, j) + G$$
$$= \sum_{j=J_0}^{J_r-1} \int \Big[(\tau_{ss} + \tau_{med}) \cdot (w - c_{EHI} \cdot \mathbb{1}_{\{\omega=1\}}) \cdot (1 - \xi \cdot \mathbb{1}_{\{cr=bad\}})\bar{\omega}_j h_c \eta\Big]\mu(d\mathbf{s}, j)$$
$$+ \sum_{j=J_0}^{\bar{J}} \int T(y)\mu(d\mathbf{s}, j).$$

(x) Distributions are consistent with individual behavior.

For all $j \le \bar{J} - 1$ and for all $B \in \mathbb{B}(\mathbf{S})$,

$$\mu(B, j+1) = \int_{\{\mathbf{s}|\left(g_a(\mathbf{s},j), g_i(\mathbf{s},j), g_h(\mathbf{s},j), \epsilon'_e, \epsilon'_n, \eta', \omega', v'\right)\in B\}} \Big[\Gamma^{v'}_{v}\ \pi_{j+1|j}(h_c, j_g)\ \pi_{\epsilon'_e|g_h(\mathbf{s},j)}\ \pi_{\epsilon'_n|g_h(\mathbf{s},j)}\ \pi_{\eta'|\eta}\ \pi_{\omega'|\eta'}\Big]\ \mu(d\mathbf{s}, j)$$

where $\mathbf{s} = (a, i, h, \epsilon_e, \epsilon_n, \eta, \omega, \upsilon) \in \mathbf{S}$ is the individual state.

(xi) Accidental bequests κ are evenly distributed to all of the households:

$$\kappa = \sum_{j=J_0}^{\bar{J}-1} \left(\int [(1 - \pi_{j+1|j}(h_c, j_g))(a(1 + r^{rf})) \cdot \mathbb{1}_{\{a>0\}}] \mu(d\mathbf{s}, j) \right).$$

Appendix F Model Performance

Life-cycle Dimensions: Figure 15 depicts the life-cycle profiles of average consumption, earnings and assets. The shape of the consumption profile is concave and relatively flatter than the other two profiles. Earnings profiles increase until the mid-40s and decline until retirement. After retirement, households receive Social Security benefits. Households save assets until their retirements and spend them afterward. The shape of the three profiles resembles that of their empirical counterparts, which are documented in Heathcote, Perri and Violante (2010) and Díaz-Giménez, Glover and Ríos-Rull (2011).

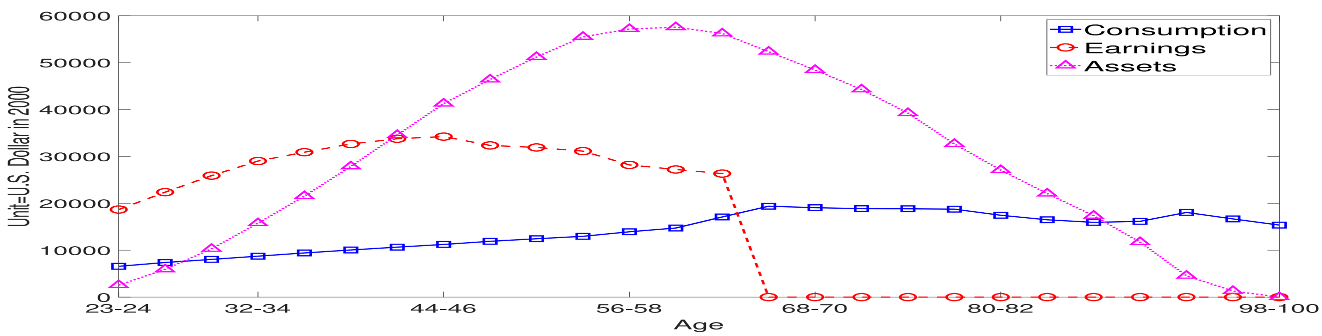


Figure 15: Age Profiles of Consumption, Earnings and Assets

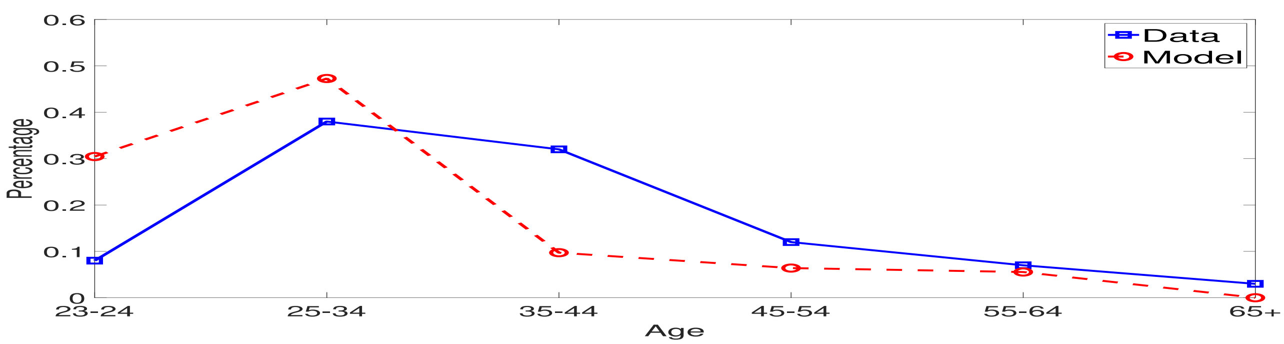


Figure 16: Age Profiles of Bankruptcy Filings (Source: Sullivan et al. (2001))

Figure 16 displays the profiles of the fraction of bankruptcy filings over the life-cycle. In the data, the life-cycle profile of bankruptcy filings is hump-shaped, and bankruptcy filers aged between 25 and 44 consist of more than half of the total bankruptcy filers. The model broadly reproduces these features well, meaning that it successfully reflects how default risks evolve over the life-cycle.

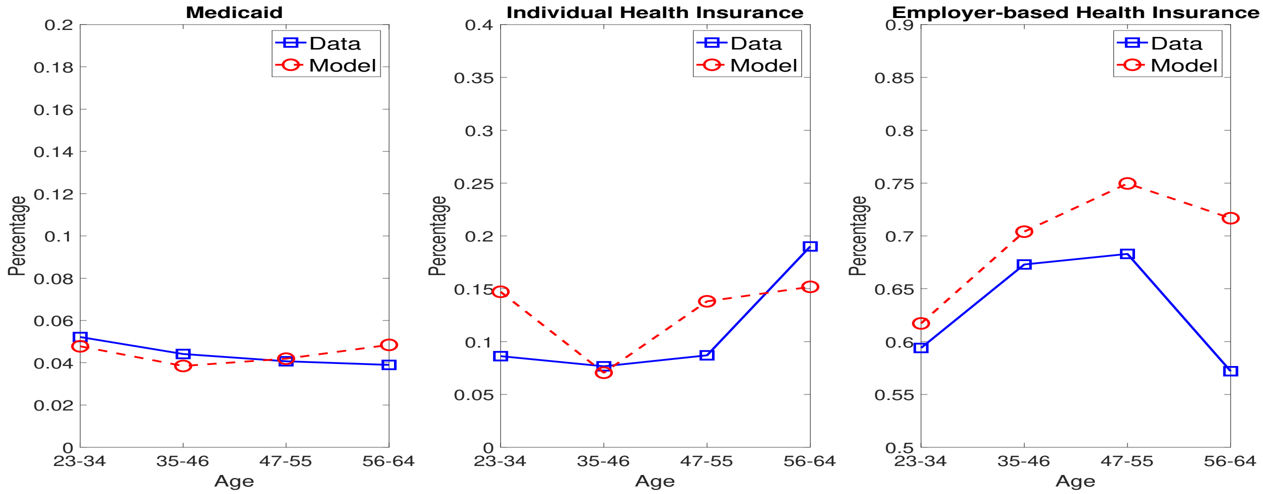


Figure 17: Age Profiles of Insurance Take-up Rates

Figure 17 shows the age profiles of take-up rates for health insurance. These take-up rates in the model are broadly similar to those in the data. Before the expansion of Medicaid under the ACA, only a small portion of working-age households used Medicaid, as it was available only to low-income households. The model generates this feature well. Regarding individual health insurance, the model reproduces the life-cycle profile well. The model also succeeds in generating the hump-shaped age profiles in employer-based health insurance in the data; however, it overestimate the take-up rate especially aged between 56 and 64. Since all households in the model are required to retire at age 65, the model fails to reproduce this.

Table 9: Untargeted Cross-sectional Moments

Moment	Empirical Value	Model Value
Debt - Earnings Ratio	0.084	0.062
Fraction of Uncompensated ER	0.502	0.257
Correlation b.w. Income and ER Visits	-0.09	-0.13
Correlation b.w. Income and Medical Conditions	-0.15	-0.29

The model period is triennial . I transform the triennial moments into annual moments.

Cross-sectional Dimensions: Table 9 shows cross-sectional moments that are not explicitly targeted. The empirical values of these moments are obtained from previous studies and the data. The empirical value for the debt-to-earnings ratio is from Livshits et al. (2007). The debt to earnings ratio is 0.084 in the data and 0.062 in the model. The fraction of uncompensated ER is computed by counting households whose total ER expenditure is less than 50 percent of the total charge of ER in the MEPS. The fraction is 0.502 in the data, and 0.257 in the model. The empirical values of these health-related moments below are from the MEPS. The model generates negative values of the correlation between income and emergency room visits and of the correlation between income and medical conditions quantified to health shocks. Note that the negative correlation values can be reproduced owing to the model's setting for the distribution of health shocks: the likelihood of emergency and non-emergency health shocks negatively depends on health capital.

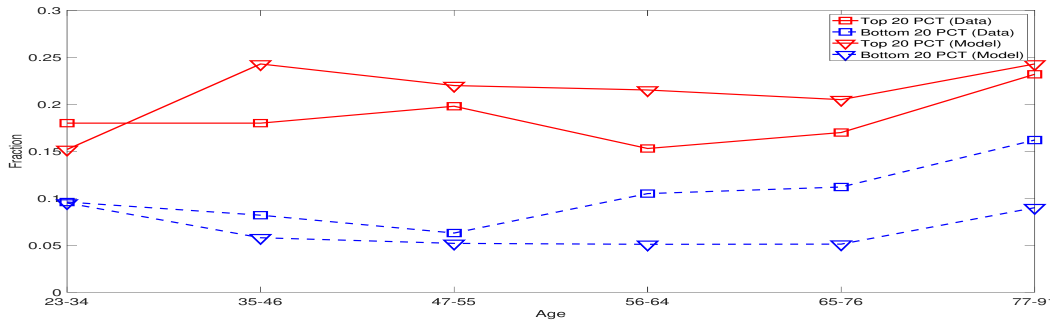


Figure 18: Bottom and Top End of the Emergency Room Usage Distribution

Figure 18 implies that the model endogenously captures the features of emergency room usage of low-income individuals and high-income individuals. The left panel of Figure 18 shows that, in the data, low-income individuals visit emergency rooms more frequently over the life-cycle, which is well-replicated in the model. Note that the fraction differs across income levels, as the distribution of emergency health shocks depends on health capital. If the distribution depended only on age, there would be no difference in visits to emergency rooms across income groups.

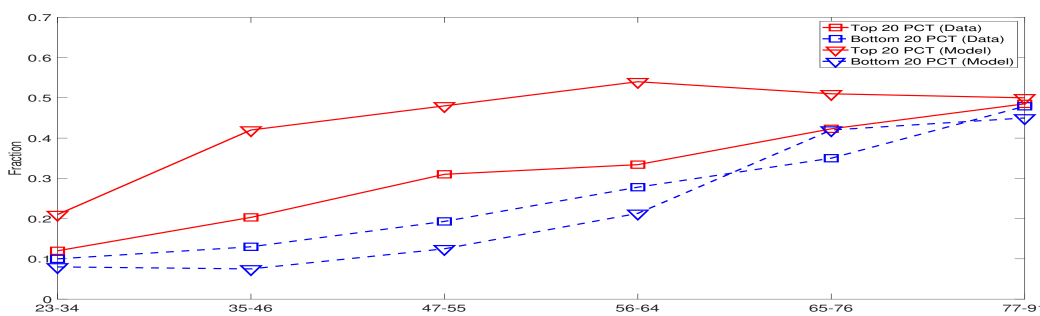


Figure 19: Bottom and Top End of the Medical Conditions Distribution

Figure 19 compares the age profiles of medical conditions between individuals in the top 20 percent of income and those in the bottom 20 percent. It implies that the model captures the distributional features of medical conditions across income groups. The left panel of Figure 19 implies that low-income individuals tend to suffer from more severe health shocks than high-income individuals, which is presented in the model's result. These successes of the model make it possible to capture asymmetric financial risks across income groups, as health risks are linked to financial risks via emergency and non-emergency medical expenses.

Appendix G Data Details

G.1 Data Cleansing

I choose the MEPS waves from 2000 to 2011. Among various data files in MEPS, by using individual id (DUPERSID), I merger three types of data files: MEPS Panel Longitudinal files, Medical Condition files, and Emergency Room visits files. To clean this data set, I take the following steps. First, I identify household units with the Health Insurance Eligibility Unit (HIEU). Second, I define household heads who have the highest labor income within a HIEU. I eliminate households in which the heads are non-respondents for key variables such as demographic features, educational information, medical expenditures, health insurance, health status, and medical conditions. Second, among working age (23-64) head households, I drop families that have no labor income. Third, I use the MEPS longitudinal weight in MEPS Panel Longitudinal file for each individual. Since each survey of MEPS Panel Longitudinal files covers 2 consequent years, I stack individuals in the 10 different panels into one data set. To use the longitudinal weight with my stacked data set, I follow the way in Jeske and Kitao (2009). As they did, I rescale the longitudinal weight in each survey to make the sum of the weight equal to the number of HIEUs. In this way, I address the issues of different size of samples across surveys and reflect the longitudinal weight in each survey. Lastly, I convert all nominal values into the value of U.S. dollar in 2000 with the CPI. The number of observations in each panel is as follows.

Year	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006
Numbers	5218	10187	7484	7577	7548	7294
Year	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	
Numbers	7721	5835	8611	7988	7020	

Table 10: MEPS Panel Sample Size

G.2 Variable Definitions

Household Unit(MEPS Panel Longitudinal files, Medical Condition files, and Emergency Room visits files): To define households, I use the Health Insurance Eligibility Units (HIEU) in the MEPS. To capture behavior related to health insurance, the HIEU is a more proper id than dwelling unit. Since the HIEU is different from dwelling unit, even within a dwelling unit, multiple HIEUs can exist. A HIEU includes spouses, unmarried natural or adoptive children of age 18 or under and children under 24 who are full-time students.

Head(MEPS Panel Longitudinal files): The MEPS does not formally define heads in households. I define head by choosing the highest earner within a HIEU.

Household Income (MEPS Panel Longitudinal files): The MEPS records individual total income (TTLPY1X and TTPLY2X). Household income is the summation of all house members' total income.

Medical Expenditures (MEPS Panel Longitudinal files): The MEPS provides information on individual total medical expenditures (TOTEXPY1 and TOTEXPY2). However, this variable includes medical expenditures paid for by Veteran's Affairs (TOTVAY1 and TOTVAY2), Workman's Compensation (TOTWCPY1 and TOTWCPY2) and other sources (TOTOSRY1 and TOTOSRY2) that are not covered in this study, I redefine the total medical expenditure variable by subtracting these three variables from the original total medical expenditure variable.

Insurance Status(MEPS Panel Longitudinal files): For working age head households, I categorize four type of health insurance status: uninsured, Medicaid, individual health insurance, and employer-based health insurance. The MEPS records whether each respondent has a health insurance, whether the insurance is provided by the government or private sectors (INSCOVY1 and ISCOVY2), and whether to use Medicaid (MCDEVY1 and MCDEVY2). Using this variable, I define the uninsured and Medicaid users. The MEPS also records employer-based health insurance holders (HELD1X, HELD2X, HELD3X, HELD4X, HELD5X) for five subsequent survey periods. I define employer-based health insurance holders who have experience in holding employer-based health insurance within a year. I define individual health insurance holders as those who do not have employer-based health insurance (HELD1X, HELD2X, HELD3X, HELD4X, HELD5X) but have a private health insurance (INSCOVY1 and INSCOVY2).

Employer-Based Health Insurance Offer rate (MEPS Panel Longitudinal files): The MEPS provides information as to whether respondents' employer offers health insurance (OFFER1X, OFFER2X, OFFER3X, OFFER4X, OFFER5X).

Medical Conditions (Medical Condition files): The Medical Condition Files in the MEPS keep track of individual medical condition records with various measures. I choose Clinical Classification Code for identifying individual medical conditions (CCCODEX).

Health Shocks (Medical Condition files and morbidity measures from the WHO): In order to quantify these individual medical conditions, I use a measure from the World Health Organization (WHO). The WHO provides two types of measures to quantify the burden of diseases: mortality measures (years of life lost to illness (YLL) and morbidity measures (years lived with disability (YLD)). I use the adjusted morbidity measure in the study of Prados (2017). Table 11 is the morbidity measures in Prados (2017).

Condition	Disab. Wgt.	Condition	Disab. Wgt.
Tuberculosis	0.23	Aortic, peripheral, and visceral artery aneurysms	0.29
Bacterial infection, unspecified site	0.04	Aortic and peripheral arterial embolism	0.29
Mycoses	0.00	Other circulatory disease	0.13
Hiv infection	0.57	Phlebitis, thrombophlebitis and thromboembolism	0.13
Hepatitis	0.08	Pneumonia (except that caused by tuberculosis or sexual	0.04
Viral infection	0.01	Influenza	0.01
Other infections, including parasitic	0.02	Acute and chronic tonsillitis	0.00
Sexually transmitted infections (not HIV or hepatitis)	0.07	Acute bronchitis	0.00
Cancer of head and neck	0.20	Other upper respiratory infections	0.00
Cancer of stomach	0.33	Chronic obstructive pulmonary diseas	0.23
Cancer of colon	0.22	Asthma	0.23
Cancer of rectum and anus	0.22	Pleurisy, pneumothorax, pulmonary collapse	0.23
Cancer of liver and intrahepatic bile duct	0.20	Respiratory failure, insufficiency, arrest	0.23
Cancer of pancreas	0.20	Lung disease due to external agents	0.04
Cancer of bronchus, lung	0.43	Other lower respiratory disease	0.04
Cancer of bone and connective tissue	0.06	Other upper respiratory disease	0.00
Melanomas of skin	0.06	Intestinal infection	0.02
Other non-epithelial cancer of skin	0.06	Gastroduodenal ulcer (except hemorrhage)	0.02
Cancer of breast	0.27	Gastritis and duodenitis	0.02
Cancer of uterus	0.10	Appendicitis and other appendiceal conditions	0.46
Cancer of cervix	0.08	Regional enteritis and ulcerative collitis	0.02
Cancer of ovary	0.10	Intestinal obstruction without hernia	0.02
Cancer of other female genital organs	0.10	Diverticulosis and diverticulitis	0.20
Cancer of prostate	0.34	Peritonitis and intestinal abscess	0.20
Cancer of testis	0.09	Nephritis, nephrosis, renal sclerosis	0.09
Cancer of bladder	0.09	Acute and unspecified renal failure	0.09
Cancer of kidney and renal pelvis	0.09	Chronic renal failure	0.10
Cancer of brain and nervous system	0.09	Urinary tract infections	0.01
Cancer of thyroid	0.09	Hyperplasia of prostate	0.04
Hodgkin's disease	0.06	Inflammatory diseases of female pelvic organs	0.33
Non-hodgkin's lymphoma	0.31	Endometriosis	0.10
Leukemias	0.09	Prolapse of female genital organs	0.10
Cancer, other and unspecified primary	0.09	Ovarian cyst	0.10
Secondary malignancies	0.75	Female infertility	0.11
Malignant neoplasm without specification of site	0.09	Ectopic pregnancy	0.55
Neoplasms of unspecified nature or uncertain behavior	0.09	Skin and subcutaneous tissue infection	0.07
Maintenance chemotherapy, radiotherapy	0.09	Other inflammatory condition of skin	0.07
Benign neoplasm of uterus	0.09	Chronic ulcer of skin	0.07
Other and unspecified benign neoplasm	0.09	Other skin disorders	0.07
Diabetes mellitus without complication	0.20	Rheumatoid arthritis and related disease	0.53
Diabetes mellitus with complications	0.20	Osteoarthritis	0.19
Nutritional deficiencies	0.03	Spondylosis, intervertebral disc dis	0.06
Gout and other crystal arthropathies	0.13	Joint disorders and dislocations, trauma related	0.07
Deficiency and other anemia	0.05	Fracture of neck of femur (hip)	0.19
Sickle cell anemia	0.05	Spinal cord injury	0.73
Meningitis (except that caused by tuberculosis or std)	0.31	Skull and face fractures	0.43
Parkinson's disease	0.68	Fracture of upper limb	0.19
Multiple sclerosis	0.53	Fracture of lower limb	0.19
Paralysis	0.57	Other fractures	0.19
Epilepsy, convulsions	0.11	Sprains and strains	0.06
Headache, including migraine	0.03	Intracranial injury	0.36
Cataract	0.10	Crushing injury or internal injury	0.22
Retinal detachments, defects, vascular occlusion and reti	0.10	Open wounds of head, neck, and trunk	0.17
Glaucoma	0.10	Open wounds of extremities	0.17
Blindness and vision defects	0.10	Superficial injury, contusion	0.17
Otitis media and related conditions	0.02	Burns	0.16
Other ear and sense organ disorders	0.07	Poisoning by other medications and d	0.17
Other nervous system disorders	0.50	Poisoning by nonmedicinal substances	0.17
Heart valve disorders	0.13	Other injuries and conditions due to	0.17
Peri-, endo-, and myocarditis, cardiomyopathy	0.32	Nausea and vomiting	0.00
Essential hypertension	0.25	Abdominal pain	0.00
Hypertension with complications and secondary hyperte	0.25	Malaise and fatigue	0.00
Acute myocardial infarction	0.15	Allergic reactions	0.00
Coronary atherosclerosis and other heart disease	0.29	Adjustment disorder	0.02
Pulmonary heart disease	0.13	Anxiety disorder	0.17
Other and ill-defined heart disease	0.13	Attention-deficit, conduct, and disruptive behavior disor	0.17
Conduction disorders	0.13	Delirium, dementia, and amnestic and other cognitive di	0.71
Cardiac dysrhythmias	0.13	Developmental disorders	0.02
Cardiac arrest and ventricular fibri	0.15	Impulse control disorders	0.13
Congestive heart failure, nonhyperte	0.15	Mood disorders	0.23
Acute cerebrovascular disease	0.61	Personality disorders	0.66
Occlusion or stenosis of precerebral arteries	0.61	Schizophrenia and other psychotic disorders	0.66
Other and ill-defined cerebrovascular disease	0.61	Alcohol-related disorders	0.55
Transient cerebral ischemia	0.61	Substance-related disorders	0.55
Late effects of cerebrovascular dise	0.61	Suicide and intentional self-inflict	0.23
Peripheral and visceral atherosclero	0.29		

Table 11: Disability Weights (Source:Prados (2017))

For calculating health shocks from medical conditions, I follow the method in Prados (2017). Let's assume that a household has D kinds of medical conditions. Denote d_i as the WHO index for medical condition i, where $i = 1, \ldots, D$. For this household, its health shock ϵ_h is represented by

$$(1 - \epsilon_h) = \prod_{i=1}^{D}(1 - d_i). \tag{42}$$

This measure well represents the features of medical condition in the sense that it reflects not only multiple medical conditions but also differences in their severity.

Emergency Room Usages and Charges (Emergency Room Visits files): Emergency Room Visits files in the MEPS record respondents who visit emergency rooms. These files records the Clinical Classification Code as to why respondents visit emergency rooms (ERCCC1X, ERCCC2X, ERCCC3x) and as to how much hospitals charge from emergency medical events to patients (ERTC00X).

Appendix H Computation Details

There are computational burdens in this problem, because not only the dimension of individual state is large, but also the value functions of the model are involved with many non-concave and non-smooth factors: the choice of default, health insurance, medical cost, progressive subsidy and tax policies.

To solve the model with these complexities, I extend the endogenous grid method of Fella (2014). He provides an algorithm to handle non-concavities on the value functions with an exogenous borrowing constraint. I generalize the method for default problems in which borrowing constraints differ across individuals.

Whereas there are several types of value functions in the model, the computational issues are mainly related to four types of value functions: the value function of non-defaulting households with a good (bad) credit history $v^{G,N}$ ($v^{B,N}$), the value function of retired households with a good (bad) credit history $v^{G,r}$ ($v^{B,r}$).[28] The value function with a bad credit history and two retired households' value functions are solved with the algorithm of Fella (2014), because these problems have an exogenous borrowing constrain with discrete choice, which is consistent with the setting of Fella (2014). My endogenous grid method is for solving the value function of non-defaulting with a good credit history $v^{G,N}$ in which loan prices differ across individuals states.[29]

In the following subsections, first, I demonstrate how to solve the value of non-defaulting households with a good credit history $v^{G,N}$ with my endogenous grid method.[30] Then, I show how to solve the other value functions with the endogenous grid method of Fella (2014).

H.1 Notation and Discretization of States

Before getting into details, let us begin with notations to explain the algorithm. To ease notation, I denote $\mathrm{s}_{-a} = (i, h, \epsilon_e, \epsilon_n, \eta, \omega, j)$ and $\mathrm{s}_p^{'} = (i^{'}, h^{'}, \eta, j)$. Then, $V^G(a, \mathrm{s}_{-a}) = V^G(a, i, h, \epsilon_e, \epsilon_n, \eta, \omega, j)$ and $q(a^{'}, \mathrm{s}_p^{'}) = q(a^{'}, i^{'}, h^{'}; j, \eta)$. I also denote $W^G(a^{'}, s_p^{'}, h_c) = W^G(a^{'}, i^{'}, h^{'}, \eta, j, h_c)$ as the expected value function of working households with good credit conditional on η, h_c, age j and age group j_g, $\pi_{j+1|j}(h_c, j_g)\, \mathbb{E}_{\epsilon_e^{'}|h^{'}, \epsilon_n^{'}|h^{'}, \eta^{'}|\eta, \omega^{'}|\eta^{'}} \left[V^G(a^{'}, \mathrm{s}_{-a}^{'})\right]$. $G_{a^{'}} = \{a_1^{'}, \cdots, a_{N_{a^{'}}}^{'}\}$ and $G_O = \{O_1, \cdots, O_{N_O}\}$ are the grid of asset holdings $a^{'}$ and cash on hand O, respectively.

In the model, households need to make choices on three individual state variables: assets a, health insurance i, and health capital h. I discretize two endogenous states: health insurance i and

[28] The value function of filing for default is not involved with any continuous choice variable.

[29] Jang and Lee (2019) extend this endogenous grid method to solve infinite horizon models with default risk and aggregate uncertainty.

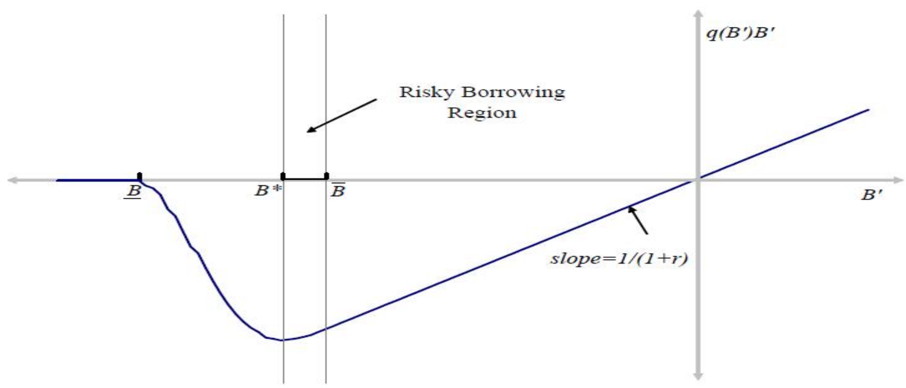
[30] The steps I use here are also described in Jang and Lee (2019). They extend this endogenous grid method to solve an infinite horizon model with default risk and aggregate uncertainty.

health capital h. I apply the endogenous grid method to assets a by taking this variable as continuous. This way is efficient because the variation of assets is the largest among the endogenous state variables. When solving the problems, I regard the choice of health insurance $\bar{i}'$ and health capital for the next period $\bar{h}'$ as given states, and apply the endogenous grid method to asset holdings a' in the next period.

H.2 Calculating the Risky Borrowing Limit (Credit Limit) $(v^{G,N})$

I set up the feasible sets of the solution based on the work in Arellano (2008) and Clausen and Strub (2017). They investigate the property of the risky borrowing limits (credit limits). They show that the size of loan $q(a')a'$ increases with a' for any optimal debt contract. If the size of loan $q(a')a'$ decreases in a', households can increase their consumption by increasing debts, which is not an optimal debt contract. Arellano (2008) (Clausen and Strub (2017)) defines the risky borrowing limit (credit limit) to be the lower bound of the set for optimal contract. For example, in Figure 20, B^* is the risky borrowing limit.

Figure 20: Risky Borrowing Limit (Arellano (2008))



For each state $s_p' = (\bar{i}', \bar{h}', j, \eta)$, I calculate the risky borrowing limit $a_{rbl}'(s_p')$ such that

$$\forall a' \geq a_{rbl}(s_p'), \frac{\partial q(a', s_p')a'}{\partial a'} = \frac{\partial q(a', s_p')}{\partial a'}a' + q(a', s_p') > 0. \tag{43}$$

I compute the numerical derivative of the discount rate of loan prices $q(a', s_p')$ over the grid of asset holdings $G_{a'}$ in the following way:

$$D_{a'}q(a_k', s_p') = \begin{cases} \frac{q(a_{k+1}', s_p') - q(a_k', s_p')}{a_{k+1}' - a_k'}, & \text{for } k < N_{a'} \\ \frac{q(a_k', s_p') - q(a_{k-1}', s_p')}{a_k' - a_{k-1}'}, & \text{for } k = N_{a'}. \end{cases} \tag{44}$$

I calculate the risky borrowing limit $a_{rbl}(\cdot)$ for each state $s_p^{'}$ and fix them as the lower bound of the feasible set for the solution of asset holdings $a^{'}$. For each state $s_p^{'}$, I denote $G_{a^{'}}^{rbl(s_p^{'})}$ as the collection of all of the grid points for asset holdings $a_k^{'}$ above the risky borrowing limit $a_{rbl}(s_p^{'})$, which means for all $a_k^{'} \in G_{a^{'}}^{rbl(s_p^{'})}$, $a_k^{'} > a_{rbl}(s_p^{'})$.

H.3 Identifying (Non-) Concave Regions

Note that the FOC (17) is not sufficient but necessary, because of non-concavities on the expected value function $W^G(a^{'}, s_p^{'})$ with respect to $a^{'}$. If the concave regions can be identified, the FOC (17) is a sufficient and necessary condition for an optimal choice of asset holdings $a^{'}$ on the concave region. I use the algorithm of Fella (2014) to divide the domain of the expected value functions $G_{a^{'}}^{rbl(s_p^{'})}$ into the concave and non-concave regions.

For each state $s_p^{'}$, the concave region is identified by two threshold grid points $\bar{a}^{'}(s_p^{'})$ and $\underline{a}^{'}(s_p^{'})$ that satisfy the following condition: for any $a_i^{'} \in G_{a^{'}}^{rbl(s_p^{'})}$ and $a_j^{'} \in G_{a^{'}}^{rbl(s_p^{'})}$ with $\bar{a}^{'}(s_p^{'}) < a_i^{'} < a_j^{'}$ ($a_i^{'} < a_j^{'} < \underline{a}^{'}(s_p^{'})$), $D_{a^{'}}W^G(a_i^{'}, s_p^{'}, h_c) > D_{a^{'}}W^G(a_j^{'}, s_p^{'}, h_c)$.[31] This condition implies that for all grid points of which values are greater than $\bar{a}^{'}(s_p^{'})$ (less than $\underline{a}^{'}(s_p^{'})$), the derivative of the expected value function $D_{a^{'}}(\cdot, s_p^{'})$ strictly decreases with asset holdings $a^{'}$.

For each state $s_p^{'}$, I take the following steps to find the thresholds $\bar{a}^{'}(s_p^{'})$ and $\underline{a}^{'}(s_p^{'})$. First, I check the discontinuous points of the derivative of the expected value function $D_{a^{'}}W^G(a^{'}, s_p^{'}, h_c)$. I compute the derivative of the expected value function $D_{a^{'}}W^G(a^{'}, s_p^{'}, h_c)$ in the same way as the derivative of the discount rate of loan price (44). Second, among the discontinuous points, I find the minimum value, which is $v_{max}(s_p^{'})$. Third, I search for the maximum $a_i^{'} \in G_{a^{'}}^{rbl(\mathbf{s}_p^{'})}$ satisfying $D_{a^{'}}W^G(a^{'}, s_p^{'}, h_c) \leq v_{max}(s_p^{'})$. The maximum is defined as $\bar{a}^{'}(s_p^{'})$. Fourth, among the discontinuous points, I find the maximum value, which is $v_{min}(s_p^{'})$. Then, I search for the minimum $a_i^{'} \in G_{a^{'}}^{rbl(\mathbf{s}_p^{'})}$ satisfying $D_{a^{'}}W^G(a^{'}, s_p^{'}, h_c) \geq v_{min}(s_p^{'})$.The minimum is defined as $\underline{a}^{'}(s_p^{'})$.

H.4 Computing the Endogenous Grid for the Cash on Hand

$$\frac{\partial q(a_k^{'}, \mathbf{s_p^{'}})\mathbf{a_k^{'}}}{\partial a^{'}} \frac{\partial u(c, h_c)}{\partial c} = \frac{\partial W^G(a_k^{'}, \mathbf{s_p^{'}}, \mathbf{h_c})}{\partial a^{'}}. \tag{45}$$

First, for each state $\mathrm{s}_p^{'}$ and h_c, and for each grid point $a_k^{'} \in G_{a^{'}}^{rbl(s_p^{'})}$, I retrieve the endogenously-driven consumption $c(a_k^{'}, \mathrm{s}_p^{'}, h_c)$ from the FOC (45). Since the utility function has a CES aggregator, the endogenously-driven consumption $c(a_k^{'}, \mathrm{s}_p^{'}, h_c)$ cannot be computed analytically. I use

[31] For each $s_p^{'}$, the thresholds are the same across h_c because the survival rate $\pi_{j+1|j}(h_c, j_g)$ is a constant number.

the bisection method to compute the endogenously-driven consumption $c(a_k^{'}, s_p^{'}, h_c)$. Second, I compute the endogenously-determined cash on hand $O(a_k^{'}, s_p^{'}, h_c) = c(a_k^{'}, s_p^{'}, h_c) + q(a_k^{'}, s_p^{'})\mathbf{a_k^{'}}$. Lastly, I store the pairs of $((a_k^{'}, s_p^{'}, h_c), O(a_k^{'}, s_p^{'}, h_c))$.

H.5 Storing the Value Function over the Endogenous Grid for Cash on Hand

For each state $s_p^{'}$ and h_c, and for each grid point $a_k \in G_{a^{'}}^{rbl(s_p^{'})}$, I compute the value function of non-defaulters with good credit $v^{G,N}$ over the endogenous grid for cash on hand $O(a_k^{'}, s_p^{'}, h_c)$ in the following way:

$$\tilde{v}^{G,N}(O(a_k^{'}, s_p^{'}, h_c), s_p^{'}, h_c) = u(O(a_k^{'}, s_p^{'}, h_c) - q(a_k^{'}, \mathbf{s_p^{'}})\mathbf{a_k^{'}}, \mathbf{h_c}) + \mathbf{B_u} + \mathbf{W^G}(\mathbf{a_k^{'}}, \mathbf{s_p^{'}}, \mathbf{h_c}). \quad (46)$$

Note that (i) (46) is irrelevant to any max operator and (ii) the value function $v^{G,N}(O(a_k^{'}, s_p^{'}), s_p^{'})$ is valued on the endogenous grid, not on the exogenous grid. I store the computed value $v^{G,N}$ over the endogenous grid for cash on hand $O(a_k^{'}, s_p^{'})$.

H.6 Identifying the Global Solution on the Endogenous Grid for Cash on Hand

Using information about the identification of (non-) concave regions on asset holdings $a^{'}$ in H.3, I identify the global solutions on the pair of $(a_k^{'}, O(a_k^{'}, s_p^{'}, h_c))$.

Specifically, I take the following steps. First, for each state $(s_p^{'}, h_c)$, I identify $(a_k^{'}, O(a_k^{'}, s_p^{'}, h_c))$ as the pairs of the global solution if $a_k^{'} \geq \bar{a}^{'}(s_p^{'})$ or $a_k^{'} \in [a_{rbl}(s_p^{'}), \underline{a}^{'}(s_p^{'})]$. Note that the FOC (17) is sufficient and necessary here, as these pairs are on the concave region of the global solution. I save these pairs.

Second, for each state $(s_p^{'}, h_c)$ and each $a_k^{'} \in (\underline{a}^{'}(s_p^{'}), \bar{a}^{'}(s_p^{'}))$, I check whether the pair of $(a_k^{'}, O(a_k^{'}, s_p^{'}, h_c))$ implies the global solution in the following way:

$$a_g^{'} = \underset{\{a_j^{'} \in (\underline{a}^{'}(s_p^{'}), \bar{a}^{'}(s_p^{'}))\}}{\text{argmax}} u(O(a_k^{'}, s_p^{'}, h_c) - q(a_j^{'}, s_p^{'})a_j^{'}, h_c) + B_u + W^G(a_j^{'}, s_p^{'}, h_c). \quad (47)$$

If $a_g^{'} = a_k^{'}$, then I identify the pair of $(a_k^{'}, O(a_k^{'}, s_p^{'}, h_c))$ as an global solution. Otherwise, I discard the pair of $(a_k^{'}, O(a_k^{'}, s_p^{'}, h_c))$.

H.7 Interpolating the Value Function on the Endogenous Grid for Assets

Given the saved pairs of $(a_k^{'}, O(a_k^{'}, \mathrm{s}_p^{'}, h_c))$ and $(i, h, \epsilon_e, \epsilon_n)$, I compute the corresponding current assets a. Due to the non-linear progressive tax and insurance subsidies, for each pair of $(a_k^{'}, O(a_k^{'}, \mathrm{s}_p^{'}, h_c))$ and for each $(i, h, \epsilon_e, \epsilon_n)$, I find the corresponding assets a by using the Newton-Raphson method. Then I obtain the pairs of $(a(a_k^{'}\mathbf{s}^{'}, \mathbf{h_c}, \mathbf{i}, \mathbf{h}, \epsilon_\mathbf{e}, \epsilon_\mathbf{n}), \mathbf{a^k})$. Note that these pairs correspond to global solutions, as the saved pairs of $(a_k^{'}, O(a_k^{'}, \mathrm{s}_p^{'}, h_c))$ implies the global solutions.

H.8 Interpolating the Value Function on the Endogenous Grid for Assets

Given the saved pairs of $(a_k^{'}, O(a_k^{'}, \mathrm{s}_p^{'}, h_c))$ and $(i, h, \epsilon_e, \epsilon_n)$, I compute the corresponding current assets a. Due to the non-linear progressive tax and insurance subsidies, for each pair of $(a_k^{'}, O(a_k^{'}, \mathrm{s}_p^{'}, h_c))$ and for each $(i, h, \epsilon_e, \epsilon_n)$, I find the corresponding assets a by using the Newton-Raphson method. Then, for each state, $(\mathrm{s}_p^{'}, i, h, \epsilon_e, \epsilon_n)$, I obtain the pairs of $(a(a_k^{'}, \mathrm{s}_p^{'}, i, h, \epsilon_e, \epsilon_n), a^{'})$. Note that these pairs correspond to global solutions, as the saved pairs of $(a_k^{'}, O(a_k^{'}, \mathrm{s}_p^{'}, h_c))$ implies the global solutions.

H.9 Evaluating the Value Function over the Exogenous Grid for the Current Assets

Since the value function $\tilde{v}^{G,N}$ and decision rule $g^{G,N}$ preserve the monotonicity with the current asset a, it is possible to interpolate the value on the exogenous grid for assets G_a. For each state $(\mathrm{s}_p^{'}, i, h, \epsilon_e, \epsilon_n)$, using a linear interpolation, I find a_0 such that $a_0 = a(a^{'} = 0, \mathrm{s}_p^{'}, i, h, \epsilon_e, \epsilon_n)$.

If the value of grid $a_i \in G_a$ is above a_0, I use a linear interpolation to compute the value function of $\tilde{v}^{G,N}$ and $g^{G,N}$ on the exogenous grid of the current assets G_a. If $a_i \in G_a$ is lower than a_0, I use the grid search method.

H.10 Optimize the discrete choices

Until this step, the choice of health insurance $i^{'}$ and health capital $h^{'}$ are given statuses. Optimize these two choices by searching the grid for each variable. The number of grid points for these variables is relatively smaller than that of grid points on asset a. Therefore, the computation is not so costly in this procedure. Formally, solve the following problems:

$$v^{G,N}(a, i, h, \epsilon_e, \epsilon_n, \eta, \omega, j) = \max_{\{i^{'}, h^{'}\}} \tilde{v}^{G,N}(a, i^{'}, h^{'}, i, h, \epsilon_e, \epsilon_n, \eta, \omega, j)$$

H.11 Interpolating the Value Function on the Grid for Assets

Given a state $\mathrm{s}_p^{'}$ and $(i, h, \epsilon_e, \epsilon_n)$, since the level of assets a has a monotonic relation with cash on hand O, it is possible to interpolate the value function $\tilde{v}^{G,N}$ and decision rule $g^{G,N}$ over the exogenous grid of cash on hand G_O into the grid for assets G_a. Due to the non-linear progressive tax and insurance subsidies, for each state $\mathrm{s}_p^{'}$ and $(i, h, \epsilon_e, \epsilon_n)$, and for each grid point of the cash on hand $O_k \in G_O$, I find the corresponding assets a by using the Newton-Raphson method.

Next, using a linear interpolation, for each state $\mathrm{s}_p^{'}$ and $(i, h, \epsilon_e, \epsilon_n)$, I evaluate the value function $\tilde{v}^{G,N}$ and decision rule $g^{G,N}$ on the grid for the current assets G_a.

H.12 Optimize the discrete choices

Until this step, the choice of health insurance $i^{'}$ and health capital $h^{'}$ are given statuses. Optimize these two choices by searching the grid for each variable. The number of grid points for these variables is relatively smaller than that of grid points on asset a. Therefore, the computation is not so costly in this procedure. Formally, solve the following problems:

$$v^{G,N}(a, i, h, \epsilon_e, \epsilon_n, \eta, \omega, j) = \max_{\{i^{'}, h^{'}\}} \tilde{v}^{G,N}(a, i^{'}, h^{'}, i, h, \epsilon_e, \epsilon_n, \eta, \omega, j)$$

H.13 Solving the Other Values

I use the grid search method to solve defaulting values $v^{G,D}$ and $v^{B,D}$, because they do not an intertemporal choice on assets and the number of grid points over health insurance i and health status h is relatively small.

For values of retired households $v^{G,r}$ and $v^{B,r}$ and values of non-defaulting households with a bad credit history $v^{B,N}$, I apply the endogenous grid method of Fella (2014). It is almost the same as the previous steps other than H.2, as there is no unsecured debt in these problems. The lower bounds of feasible solution set are given by zero assets ($v^{B,N}$, $v^{B,r}$) or the natural borrowing limit ($v^{G,r}$). Precisely, with the predetermined borrowing limits, I take the steps of Section H.1 and Section H.3- Section H.11.

H.14 Updating the Expected Value Functions and Loan Price Schedules for age $j-1$

First, I update the value functions $V^G(\mathbf{s})$ and $V^B(\mathbf{s})$.

$$
\begin{aligned}
V^G(\mathbf{s}) &= \max\{v^{G,N}(\mathbf{s}), v^{G,D}(\mathbf{s}_{-\mathbf{a}})\} \\
V^B(\mathbf{s}) &= \max\{v^{G,N}(\mathbf{s}), v^{G,D}(\mathbf{s}_{-\mathbf{a}})\}
\end{aligned}
\tag{48}
$$

Second, I update the expected value functions $W^G(\mathbf{s}_p^{'}, h_c)$ and $W^B(\mathbf{s}_p^{'}, h_c)$ for age $j-1$ and age group j_g.

$$
\begin{aligned}
W^G(a^{'}, i^{'}, h^{'}, \eta, j, h_c) &= \pi_{j|j-1}(h_c, j_g) \sum_{\epsilon_n^{'}, \epsilon_e^{'}, \eta^{'}, \omega^{'}} \pi_{\epsilon_e^{'}|h^{'}} \pi_{\epsilon_n^{'}|h^{'}} \pi_{\eta^{'}|\eta} \pi_{\omega^{'}|\eta^{'}} V^G(a^{'}, i^{'}, h^{'}, \eta_e^{'}, \eta_n^{'}, \eta^{'}, \omega^{'}, j) \\
W^B(a^{'}, i^{'}, h^{'}, \eta, j, h_c) &= \pi_{j|j-1}(h_c, j_g) \sum_{\epsilon_n^{'}, \epsilon_e^{'}, \eta^{'}, \omega^{'}} \pi_{\epsilon_e^{'}|h^{'}} \pi_{\epsilon_n^{'}|h^{'}} \pi_{\eta^{'}|\eta} \pi_{\omega^{'}|\eta^{'}} V^B(a^{'}, i^{'}, h^{'}, \eta_e^{'}, \eta_n^{'}, \eta^{'}, \omega^{'}, j)
\end{aligned}
\tag{49}
$$

Lastly, the loan price function $q(a^{'}, i^{'}, h^{'};, j-1, \eta)$ is updated in the following way:

$$
d(a^{'}, i^{'}, h^{'}; j-1, \eta) = \sum_{\epsilon_n^{'}, \epsilon_e^{'}, \eta^{'}, \omega^{'}} \pi_{\epsilon_e^{'}|h^{'}} \pi_{\epsilon_n^{'}|h^{'}} \pi_{\eta^{'}|\eta} \pi_{\omega^{'}|\eta^{'}} \mathbb{1}_{\{v^{G,N}(a^{'}, i^{'}, h^{'}, \epsilon_e^{'}, \epsilon_n^{'}, \eta^{'}, \omega^{'}, j) \leq v^{G,D}(i^{'}, h^{'}, \epsilon_e^{'}, \epsilon_n^{'}, \eta^{'}, \omega^{'}, j)\}}
$$

$$
q(a^{'}, i^{'}, h^{'}; j-1, \eta) = \frac{1 - d(a^{'}, i^{'}, h^{'}; j, \eta)}{1 + r^{rf}}
$$

where $d(a^{'}, i^{'}, h^{'}; j-1, \eta)$ is the expected default probability with state $(a^{'}, i^{'}, h^{'}; j-1, \eta)$.

I repeatedly take these steps (G.1 - G.10) until the initial age.

Appendix I Offer Rate of Employer-Based Health Insurance

Table 12: Estimation Results

	Age			
Parameters	23-34	35-46	47-55	56-64
$\beta_{j_g,0}$	-1.378	-1.196	-0.888	-0.934
$\beta_{j_g,1}$	5.735	5.209	4.655	4.338
$\beta_{j_g,2}$	-2.412	-2.217	-1.936	-1.910
$\beta_{j_g,3}$	0.297	0.283	0.241	0.248

Source: author's calculation based on the MEPS 2000-2011

Appendix J Macro outcomes for the Strategic Default Option and Borrowing

Table 13: Effect of Strategic Default Option and Borrowing on Aggregate Variables

Moment	Benchmark	Costly Default	No Borrowing
Y	1*	1.027	1.026
K/Y	2.96	3.08	3.10
Risk-free Int. Rate	4%	3.56%	3.50%
AVG BOR. Int. Rate	17%	5%	-
Debt/Earnings	0.062	0.053	0
AVG B.K. Rate	1.21%	0.08%	0.09%
Frac of B.K. with Med. Bills	0.626	0.986	0.989
AVG Cons	0.353	0.345	0.343
STD of Log Cons	0.700	0.784	0.801
AVG Tax Rate	28.1%	28.5%	28.5%

The model period is triennial . I transform the triennial moments into annual moments.

* I normalize the output value in the benchmark model to default to 1.

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