Too Much Information:
Health Insurance Choice and the Affordable Care Act

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Abstracts

Too Much Information: Health Insurance Choice and the Affordable Care Act
The Patient Protection and Affordable Care Act (ACA) regulates health insurance premium pricing, expands public insurance, subsidizes premiums, and penalizes the uninsured. I analyze how each of these four components affects insurance choice, employment, and welfare by building a general equilibrium life cycle model. Households choose from public and private health insurance options and face idiosyncratic productivity and medical expenditure shocks. To analyze the premium pricing regulation I incorporate a signaling game of asymmetric information. I compare the case where insurers pool households into a single pool, as the ACA requires, and the case where they pool households separately by coverage level. With separate pools, insurers condition premiums on the information about medical expenditure risk revealed by the signal of a household's desired coverage level. I calibrate the model with pre-ACA data from the Medical Expenditure and Panel Survey and find that the model closely matches early post-ACA enrollment data. Only with a single risk pool do consumers choose the highest coverage plans. With separate pools the markets for high coverage plans completely unwind, lowering the welfare gains of the reform. Less information is better. Further counterfactual experiments reveal that while the penalty lowers the uninsured rate, it also lowers average welfare. The premium subsidy increases the number of insured and welfare, but also encourages early retirement.

The Bills of Health: The Affordable Care Act and Personal Bankruptcy
Medical expenses are one of the leading causes of personal bankruptcy in the United States. This paper analyzes the effect of the Patient Protection and Affordable Care Act (ACA) on the default rate and medical debt of U.S. households using a general equilibrium life cycle model of consumption, savings, and unsecured borrowing. Households face idiosyncratic productivity and medical expenditure shocks and can choose from public and private health insurance options. I calibrate the model with data from the Medical Expenditure Panel Survey, Survey of Consumer Finances, and the Consumer Bankruptcy Project to match aggregate measures of insurance, employment, default, borrowing, and debt. By significantly reducing the number of uninsured households, the ACA reduces the default rate by about a third. The decrease in default probability lowers interest rates and the markup hospitals charge to offset the losses from unpaid bills. These changes reduce the cost of consumption smoothing and the size of out-of-pocket medical expenses, improving the welfare gains of the reform.

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Chapter 1

Too Much Information: Health Insurance Choice and the Affordable Care Act

1.1 Introduction

The Patient Protection and Affordable Care Act (ACA) has significantly affected the provision of public and private health insurance, altering the manner in which U.S. households share $2.9 trillion in annual healthcare expenses.[1] From October 2013 to March 2015 the number of adults aged 18 or older with health insurance rose by 16.4 million, lowering the uninsured rate from 20.3% to 13.2%, with more expected to enroll in upcoming years.[2] To cause this change, the law (1) regulates premium pricing in the private individual market and (2) expands eligibility for public insurance.[3] Furthermore, consumers are induced to purchase private insurance by (3) facing penalties for going uninsured and (4) receiving premium subsidies. I analyze

[1]National health expenditure data for 2013 from Centers for Medicare & Medicaid Services, https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/NationalHealthAccountsProjected.html

[2]U.S. Department of Health and Human Services, Office of the Assistant Secretary for Planning and Evaluation, http://aspe.hhs.gov/sites/default/files/pdf/83966/ib_uninsured_change.pdf. HHS uses October 2013 as a baseline to measure the ACA's performance because the date marks the beginning of the law's implementation.

[3]The private individual market is where households purchase an individual plan directly from the insurer, as opposed to the group market where consumers purchase health insurance through their employers.

how each of these regulations affects households' insurance decisions and contributes to the law's welfare changes. Since a majority of pre-ACA working age Americans purchase insurance through their employer or obtain public insurance, I also model the regulations' effect on employment and taxation.[4] I give particular attention to the changes imposed on insurer's information set by the premium pricing regulation. Rather than adopt a "one size fits all" approach, the law requires that private individual insurers offer consumers multiple plans, which vary in the share of medical expenses covered.[5] While the premium pricing regulation seeks to prevent insurers from conditioning individual premiums on medical expenditure risk, coverage level choice reveals information about risk because riskier households demand more coverage.

In order to explore how each of the ACA's regulations affects health insurance coverage and hence the relative attractiveness of working or seeking government-provided insurance, I model the pre- and post-ACA insurance markets, labor productivity, and the government's insurance and transfer programs. I construct a general equilibrium, life cycle model of consumption and savings. I incorporate exogenous productivity and medical expenditure shocks, based on Pashchenko and Porapakkarm (2012), and a competitive health insurance market with multiple coverage levels. Households are heterogeneous in education, which determines average productivity over their working years and the probability of receiving an employer sponsored group insurance offer. Households with higher medical expenses experience lower productivity, suffer an additional loss to leisure from working, and have a lower survival probability. While labor income risk is uninsurable, households can partially insure against medical expenditure shocks.[6] Prior to the ACA, health insurance is available by three means: employer sponsored group health insurance (ESHI), public insurance, and the private individual market. ESHI pools all participating employees of the firm

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[4]Pre-ACA, pooled data from the Medical Expenditure and Panel Survey (MEPS) for 2000-2010 shows 63% of household heads aged 25 to 64 with employer group insurance and 11% with public insurance.

[5]The availability of multiple coverage levels contrasts sharply with the employer sponsored group market where 84% of firms offer only one plan and 14% offer two. Kaiser Family Foundation, 2010 Annual Survey of Employer Health Benefits, `https://kaiserfamilyfoundation.files.wordpress.com/2013/04/8085.pdf`

[6]Having insurance does not affect the size of a household's medical expenditures.

and charges a uniform, firm-subsidized premium, which is financed out of a wage deduction. Public insurance has two components. The government provides insurance to working-age, lower income households through programs like Medicaid for free, and to retired households, through programs like Medicare, at a subsidized price. In the individual market, households buy plans directly from the insurer. Pre-ACA, individual market insurers engage in underwriting which allows them to observe all state variables relevant to a household's medical expenditure risk. Thus, premiums for the same plan vary across households according to risk. I calibrate the model to match key moments of the pre-ACA labor and insurance markets using data from the Medial Expenditure and Panel Survey (MEPS) from 2000 to 2010. More specifically, I match the employment rates and average income levels by medical expenditure risk and education and I match the market shares of the different insurance options for working age households.

Before I detail the components of the post-ACA model and their effects, I briefly want to bolster the validity of the model's calibration by comparing the post-ACA model's predictions to early ACA enrollment data, a period before the penalty went fully into effect. With a partial penalty, the relative shares of {Bronze, Silver, Gold, Platinum} plans in the individual market are {24,65,1,10%}.[7] This prediction closely matches the shares observed in early ACA enrollment data of {21,70,6,2%}.[8]

The focus of this research is the ACA's premium pricing regulation. The regulation stipulates that private individual insurers must offer the same premium to all households of the same age for the same plan and cannot deny enrollment, a practice known as age-adjusted community rating with guaranteed issue. Previous literature has found that such uniform pricing requirements worsen adverse selection in the ESHI group market when choice over coverage level is present.[9] But my research

[7]Insurance plans on the individual market are categorized into tiers depending on the share of medical expenses covered by the insurer. The naming convention is Bronze, Silver, Gold, or Platinum, depending on whether the plan covers at least 60%, 70%, 80%, or 90%, respectively. Per law, in the post-ACA setting Bronze plans with 60% cost sharing are the minimum level allowed by a plan.

[8]The model does not match the share of Gold and Platinum as well because Platinum plans are not offered in certain geographic areas. Early enrollment data from the Dept. of Health and Human Services, http://aspe.hhs.gov/sites/default/files/pdf/83656/ib_2015mar_enrollment.pdf

[9]See Cutler and Reber (1998), Cutler and Zeckhauser (1998), Bundorf, Levin, and Mahoney (2008), Einav, Finkelstein, and Cullen (2008), and Carlin and Town (2009). Because of self-selction

delivers a crucial caveat. Choice can increase welfare depending on how enrollees are pooled.

More specifically, the premium pricing regulation states that variation in premiums across coverage levels at each age must not reflect differences in the riskiness of enrollees. Because riskier consumers demand higher coverage plans their desired coverage level is an informative signal of their medical expenditure risk. To prevent insurers from using the information contained in these signals, the ACA requires individual market insurers combine enrollees across all plans into a single risk pool for each age. Premiums for different coverage levels are then priced based on the average expected medical expenditure risk across all enrollees and plans. To analyze the effect of the single risk pool regulation I perform a counterfactual where I allow insurers to form separate risk pools for each coverage level. With separate pools, the premium of a plan is based on the average expected medical expenditure risk of the enrollees who select that plan.

In the baseline post-ACA model, including all the ACA's components, the uninsured rate falls to 5.6% and the individual market is chosen by 18.4% of working age adults and the relative shares of {Bronze, Silver, Gold, Platinum} plans are {34,47,2,18%}. Removing the single risk pool regulation and allowing insurers to form separate risk pools for each coverage level further lowers the uninsured rate to 3.7% and grows the individual market to 19.9%, but the relative shares across coverage levels become {59,41,0,0%}. Adverse selection is halted at the Silver level by the subsidy. More low risk households purchase insurance because they can signal their type by selecting a low coverage plan and pay a lower premium. But absent the single risk pool, desiring a high coverage plan signals high risk. The resulting premium increases set off an adverse selection spiral that completely unravels the market for Gold and Platinum plans. Because the single risk pool allows riskier households to get more coverage, welfare is 0.33% *higher* compared to separate risk pools.[10] The first key result of this paper is that not allowing insurers to use the information revealed by choice improves overall welfare.

issues choice in ESHI is rare, as shown in footnote (3).

[10] Welfare is measured by the consumption equivalent variation of newborn households. Consumption equivalent variation measures the amount of annual consumption a household would give up in order to be indifferent between living under the ACA or not.

This result is consistent with the findings of Handel et al. (2013) and Layton (2014), which show that pooling enrollees separately by coverage level can unravel the markets for higher coverage plans. But whereas these previous two papers include only two choices of coverage level in a partial equilibrium analysis, to compare risk pooling arrangements I model all the coverage levels available to consumers in a general equilibrium framework by utilizing the methodology of Athreya, Tam, and Young (2012,2013) for computing Perfect Bayesian Equilibrium in signaling games of asymmetric information. Expanding the choice set of coverage levels allows my model to properly characterize the interaction between the premium pricing regulation and the subsidy and match early enrollment data on the distribution of coverage level choice. With only two choices and a single risk pool, Handel et al. (2013) predicts a 49% market share for the Platinum plan, well in excess of what the early data shows. Problematically, over predicting the amount of risk sharing would put an upward bias on their welfare estimates.

Moving on to the other components of the ACA, households who go uninsured pay a penalty. Such a penalty induces less medically risky households to buy insurance. In the pre-ACA model the uninsured rate was 23.1%. Without the penalty the post-ACA uninsured rate is 16.0%, suggesting that the penalty is motivating the bulk of the formerly uninsured to purchase insurance. However, the penalty transfers resources from low risk to high risk households. But low risk, high income households were typically enrolled in ESHI group insurance before the ACA and are unaffected by the introduction of the penalty. Thus the second key result of this paper is that the penalty hurts households with low income and low medical expenditure risk, *lowering* average welfare by 0.48%. This result contradicts Hackman, Kolstad, and Kowalski (2015), which finds that a penalty increases welfare. But their model includes only one type of insurance plan, not multiple coverage levels. As shown by Azevedo and Gottlieb (2014), since low risk households favor lower coverage plans, the resulting premium decline for lower coverage plans induces some households, who previously favored higher coverage plans, to switch. Without this switching effect, models with only one insurance choice overstate the welfare gains of a penalty.

The government also provides a subsidy to lower income households so that their premium does not exceed a certain portion of their income. The subsidy is only applied to plans in the second lowest coverage tier (Silver).[11] While the subsidy encourages households to buy insurance, it also concentrates participation at the Silver level. Since the subsidy depends on income, it also distorts households' labor decisions. The premium subsidy reduces the number of uninsured and increases the popularity of Silver plans, for in its absence 11.4% of working age households go uninsured and only 5.1% of individual market enrollees select Silver, compared to 46.9% choosing Silver in the post-ACA baseline. However, provisioning the subsidy induces significant changes in employment. Pre-ACA, households with high medical expenditure risk work more years in order to access the ESHI group market. Post-ACA, these households retire earlier, lower their income, qualify for the subsidy, and obtain insurance through the individual market.[12] The influx of high-risk types raises premiums at older ages, making more households eligible for the subsidy and encouraging further switching to the Silver level. By age 64 the share of individual market enrollees selecting Silver reaches over 90%.

Lastly, the income eligibility for public insurance during working ages is relaxed. As highlighted by Clemens (2014), because health is negatively correlated with income, Medicaid removes consumers of higher medical expenditure risk from the private market, lowering the prices of private insurance and reducing adverse selection.[13] Including the Medicaid expansion is necessary to properly characterize the distribution of households seeking private insurance. The closest research to mine, Handel et al. (2013), does not include the Medicaid expansion and thus fails to capture its effects on premiums, employment, and taxation.

In the post-ACA baseline the overall employment rate is unchanged because the early retirement effect of the subsidy is offset by the positive effects of the public insurance expansion and penalty on employment at younger ages. However, the change in the composition of the labor force causes average labor productivity to fall. Lower

[11]In practice, the ACA contains two subsidies, a premium subsidy and a cost sharing subsidy. The premium subsidy is available on any plan while the cost sharing subsidy is only available on the Silver plan. For simplicity I combine the two. I assume there is only a premium subsidy and it only applies to the Silver plan.

[12]This result is consistent with Gruber and Madrian (1995), who find that the outside option of continuation coverage induces earlier retirement.

[13]Clemens (2014) does not account for the Medicaid's expansion effect on taxes, undermining the welfare analysis.

wages worsen the fiscal position of programs like Social Security and Medicare, which rely on payroll taxes. However, the increased spending from the Medicaid insurance expansion is the primary cause of the 1.2% increase in the proportional income tax rate needed to balance the government's budget. Overall, average welfare increases 1.76% compared to the pre-ACA economy.

The remainder of this paper is organized as follows. Section 1.2 describes the structure of the model. Section 1.3 details the calibration of the model's parameters. Section 1.4 provides a comparison the pre-ACA version of the model to the MEPS data. Section 1.5 analyzes the results of the post-ACA version of the model and the general equilibrium effects of the reform. Section 1.6 decomposes the effect of each regulation through counterfactuals. Section 1.7 concludes.

1.2 The Model

In this section I first describe the timing of the model. I then describe the shocks faced by the household and their optimization problem. Next, I discuss insurers' premium pricing behavior, the firm's optimization problem, and the government's budget constraint. I conclude with a description of the equilibrium to the signaling game and the competitive equilibrium. To ease the notation I dispense with indexing the households by i.

1.2.1 Timing

The agents in the model are households, firms, health insurers, and the government. Before I detail the specifics of the model's structure, I briefly describe the timing of the model, summarized in Figure (1.1). At the beginning of their lives households are endowed with education, e. Individuals of age $j-1$ survive to age j with probability $\psi_{j,m_{j-1}}$, which is a function of age and previous medical shock, m_{j-1}. Conditional on surviving, agents realize their productivity, $z_{j,e,m_{j-1}}$, and their ESHI offer, g_j. Next, agents choose their labor supply, l_j. Simultaneous to the labor supply decision, agents must decide their health insurance coverage rate, q_j.

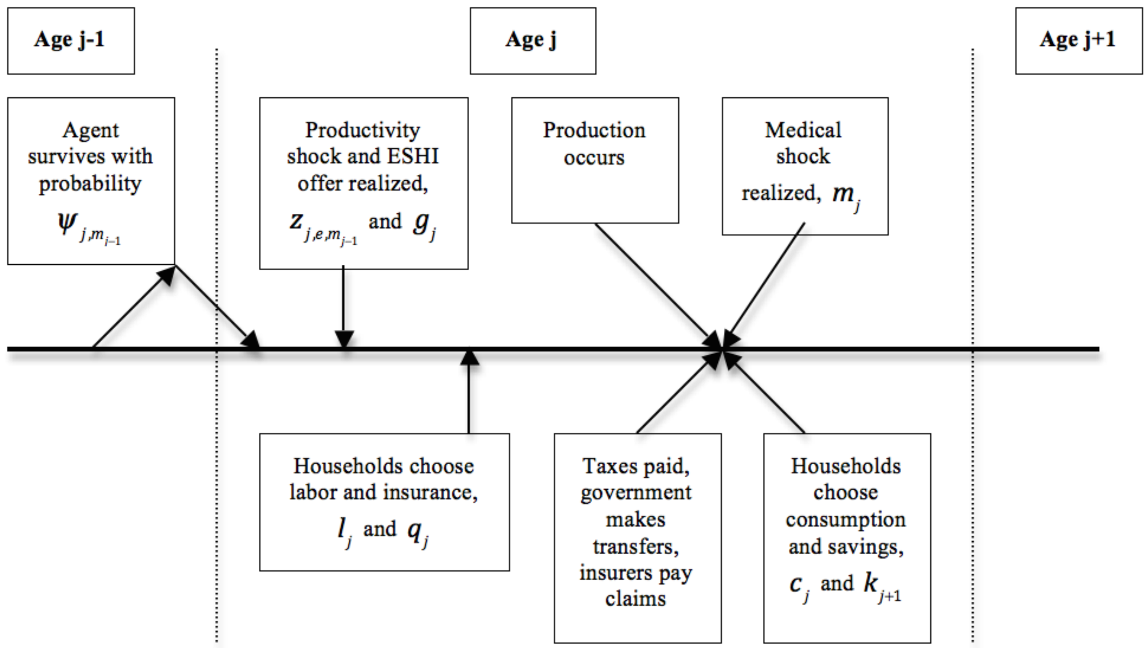
In the second stage of the period, the following events occur simultaneously. Production occurs where capital is paid a rental rate, r, and labor is paid a wage per effective unit, w. These prices are determined in equilibrium. Agents realize their medical expenditure shock, m_j. The government collects income, payroll and consumption taxes, makes transfers for the retired (hereafter referred to as Social Security), public insurance (Medicare and Medicaid), and social assistance. Households choose consumption, c_j, and next period's savings, k_{j+1}.

1.2.2 Households

Demographics and Preferences

The economy consists of a unit measure of overlapping generations of households, working-age and retired, who live a maximum of $J < \infty$ periods. Individuals spend

Figure 1.1: The Timing of Shock and Decisions in the Model



the first $j^* - 1$ periods of life working and retire exogenously at age j^*. Retired individuals live off of savings, Social Security, and Medicare. Individuals of age $j - 1$ survive to age j with probability $\psi_{j,m_{j-1}}$, which depends on their age and last period's medical shock, m_{j-1}. Individuals with smaller medical shocks are more likely to survive to the next period at every age. I assume that the assets of all deceased individuals are pooled by education and then uniformly redistributed to working age households according to educational status in an amount B_e. Individuals have a pure time discount factor of β. Individuals are endowed with education, e, at the start of their lives. Education determines average productivity during households working years.

Households' preferences over consumption and leisure are given a Cobb-Douglas specification. Utility over the composite is given an isoelastic form of

$$u(c_j, l_j) = \frac{(c_j^{\chi}(1 - l_j - \mathbf{1}_{\{l_j>0\}}\phi_{j,e,m_j})^{1-\chi})^{1-\sigma}}{1 - \sigma} \tag{1.1}$$

which is a function of consumption, leisure, and a fixed cost to leisure which depends on the medical expenditure shock, explained later. $1/\sigma$ is the intertemporal elasticity of substitution. χ is the parameter determining the relative importance of consumption and leisure. ϕ_{j,e,m_j} is the fixed cost to leisure of working and depends on age and the medical shock.

Productivity and ESHI Group Offer

Productivity at age j is given by $z_{j,e,m_{j-1}}$, which is the log sum of a deterministic term, $\lambda_{j,e,m_{j-1}}$, and two shocks. One shock, υ_j, is a persistent AR(1) process, which captures persistent changes in income. The other shock, ζ_j, is white noise which captures transitory changes income. The deterministic term, which is a function of age, education, and the medical shock, determines the mean of income at each age. Higher educational attainment generates a steeper hump in agents' productivity profile over their life cycle. Productivity can be expressed as

$$\begin{aligned} z_{j,e,m_{j-1}} &= \lambda_{j,e,m_{j-1}} exp(\upsilon_j) exp(\zeta_j) \\ \text{where} \quad \upsilon &= \rho \upsilon_{j-1} + \epsilon_j^z, \quad \epsilon_j^z \sim N(0,\sigma_z^2), \quad \text{and} \quad \zeta_j \sim N(0,\sigma_\zeta^2). \end{aligned} \tag{1.2}$$

The parameter ρ controls the degree of persistence in the AR(1) process. Total labor income can be written as $\widetilde{w} l_j z_{j,e,m_{j-1}}$. Workers not in the ESHI group market earn $\widetilde{w} = w$, where w is wage per effective unit of labor. The workers in the ESHI group receive a wage per effective unit of labor of $\widetilde{w} = w - c_E$, where c_E is a deduction used to finance the firm's share of the ESHI premium.

Simultaneous to the productivity shock, a working age agent receives an exogenous ESHI group offer, $g_j \in \{0, 1\}$, where $g_j = 1$ signifies the receipt of an offer, $g_j = 0$ otherwise. The probability of getting an offer depends on education, income, and the previous period's offer status.

After the realization of the productivity and ESHI shocks agents choose their labor supply, $l_j \in \{0, l_{PT}, l_{FT}\}$, with the choices corresponding to unemployment, part-time employment, and full-time employment, respectively.

Medical Expenditures

After the labor supply and insurance decisions are made, an individual receives an exogenous, medical expenditure shock, m_j. The medical expenditure shock evolves according to a Markov process, $\Omega(m_j|m_{j-1}, j)$, that depends on age and the previous medical expenditure shock. The medical expenditure shock influences the decisions of agents through multiple transmission channels. Not only do medical expenditures enter the household's budget constraint, they also affect survival probability, next period's productivity, and utility from leisure while working. Because the government provides health insurance for the elderly and needy through Medicare and Medicaid, these medical shocks also influence the income tax rate.

Pre-ACA Insurance Choices and Premiums

Health insurance contracts are sold in a competitive market. Before the realization of the medical expenditure shock, m_j, and simultaneous to the labor supply decision, agents choose their coverage rate, q_j, i.e. the share of their medical expenses above a deductible, d, to be covered by the insurer. Out-of-pocket medical expenses, $O(m_j, q_j)$, of a working age individual age j can be written as

$$O(m_j, q_j) = (1 - q_j)max\{0, m_j - d\} + min\{m_j, d\}. \tag{1.3}$$

In the individual market prior to the ACA, the set of coverage rates are $q_j \in (0, 1]$. $q_j = 0$ corresponds to going uninsured. The coverage rate is the only differentiating feature of the individual market plans. The choice set in the ESHI group market is $q_j \in \{0, q_g\}$. Households with an ESHI group offer can purchase a plan through the individual market, but in the model none do because of the premium subsidy offered by the firm. In order to participate in the group market the worker must receive an ESHI offer and be employed full-time at the firm.

The price of the health insurance premium is p. In the individual market the premium is $p = p(q_j, \mathcal{I})$, a function of the desired level of coverage and the information observable to the insurer, $\mathcal{I}$. In the group market all participants pay the same premium, $p = (1 - \mu)p_g$, where μ is the share of the premium covered by the employer. The ESHI premium is tax deductible. Note that the ESHI group premium does not vary according to age or risk. In contrast, through underwriting insurers in the individual market know the medical history and age of enrollees, $\mathcal{I} = (m_{j-1}, j)$, which is the only information needed to calculate expected medical expenses. Individual insurance premiums are thus conditioned on medical expenditure risk. Working age individuals whose total taxable income, y_j, is below a certain threshold, y_{mcd}, are automatically enrolled in public insurance (hereafter referred to as Medicaid) and for zero premium receive a coverage rate q_{mcd}. Retired individuals are automatically enrolled in public insurance (hereafter referred to as the Medicare), where the premium and coverage rate, p_{mcr} and q_{mcr}, are set by law. Only private individual and group insurance have a deductible. I assume Medicare and Medicaid do not have a deductible. For enrollees in public insurance, out of pocket medical expenses are given by equation (1.3), where d, the deductible, is set to zero.

Optimization Problem

Simultaneous to the medical expenditure shock, the agent chooses next period's savings, $k_{j+1} \in \mathbb{R}^+$, and consumption, $c_j \in \mathbb{R}^+$, while the government charges all individuals a progressive income tax, $T(y_j)$, a proportional income tax, τ_y, and a proportional consumption tax, τ_c. Working individuals also pay proportional Social Security, τ_{ss}, and Medicare, τ_{mcr}, payroll taxes, i.e. on labor income only. At age j the state space of the working age household can be written as $(j, e, k_j, z_{j,e,m_{j-1}}, m_{j-1}, g_j)$ and the choice variables of the household are (q_j, l_j, k_{j+1}, c_j). A description of the retired household follows the working age household.

Working age ($j < j^*$) households' value function can be written as

$$\begin{aligned} V(j, e, &k_j, z_{j,e,m_{j-1}}, m_{j-1}, g_j) = \\ &\max_{q_j, l_j, k_{j+1}, c_j} u(c_j, l_j) + \beta\psi_{j+1,m_j} E\Big[V(j+1, e, k_{j+1}, z_{j+1,e,m_j}, m_j, g_{j+1})\Big] \end{aligned} \tag{1.4}$$

subject to

$$(1+r)k_j + \widetilde{w} z_{j,e,m_{j-1}} l_j + T_{SI} + B_e \geq k_{j+1} + (1+\tau_c)c_j + O(m_j, q_j) + Tax + p \tag{1.5}$$

and

$$\begin{aligned} Tax = T(y_j) + \tau_y y_j + &\tau_{mcr}(\widetilde{w} z_{j,e,m_{j-1}} l_j - \mathbf{1}_{\{q_j = q_g\}} p) \\ &+ \tau_{ss}\Big(max\{\widetilde{w} z_{j,e,m_{j-1}} l_j - \mathbf{1}_{\{q_j=q_g\}} p, \overline{y}_{ss}\}\Big) \end{aligned} \tag{1.6}$$

where $y_j = rk_j + \widetilde{w} z_{j,e,m_{j-1}} l_j - \mathbf{1}_{\{q_j=q_g\}} p$ is taxable income. B_e is the education specific bequest. Per law, the premium on group health insurance is tax deductible and the social security payroll tax is only charged on income below a certain threshold, $\overline{y}_{ss}$. T_{SI} represents the lump sum transfer from the government's social assistance program. The program guarantees all agents receive a minimum level of consumption, $\underline{c}$. The size of the transfer is given by

$$T_{SI} = max\Big\{0, (1+\tau_c)\underline{c} + O(m_j, q_j) + Tax + p - (1+r)k_j - \widetilde{w} z_{j,e,m_{j-1}} l_j - B_e\Big\}. \tag{1.7}$$

Retirement age ($j \geq j^*$) households' value function can be written as

$$V(j, e, k_j, m_{j-1}) = \max_{k_{j+1}, c_j} u(c_j) + \beta \psi_{j+1,m_j} E\Big[V(j+1, e, k_{j+1}, m_j)\Big] \tag{1.8}$$

subject to

$$(1+r)k_j + ss_e + T_{SI} \geq k_{j+1} + (1+\tau_c)c_j + m_j(1-q_{mcr}) + Tax + p_{mcr} \tag{1.9}$$

and

$$Tax = T(y_{j,ret}) + \tau_y y_{j,ret} \tag{1.10}$$

where $y_{j,ret} = rk_j + ss_e$ is taxable income of a retired household and ss_e is the Social Security transfer, which depends on education. Per law, Social Security transfers are a function of lifetime earnings, but to improve the tractability of my model I compute the size of the transfer as a fraction, i.e. the Social Security replacement rate, of the average income for each educational group. After retirement, the lump sum transfer for social assistance becomes

$$T_{SI} = max\Big\{0, (1+\tau_c)\underline{c} + m_j(1-q_{mcr}) + Tax + p_{mcr} - ss_e - (1+r)k_j\Big\} \tag{1.11}$$

To ease notation, let the space of the household's state variables be defined by X, i.e. the set of all combinations of $x = (j, e, k_j, z_{j,e,m_{j-1}}, m_{j-1}, g_j)$ for a working-age household and $x = (j, e, k_j, m_{j-1})$ for a retired household. Let $\Gamma(X)$ be defined as the distribution of households over this space.

1.2.3 Premium Pricing

Pre-ACA Premium Pricing

In the individual market agents choose a coverage rate, q_j, for medical expenses above a deductible, d, and view premium prices as parametric, and given by the function $p(q_j, \mathcal{I})$. $\mathcal{I}$ denotes the information observable to insurers prior to the realization of the medical expenditure shock. I define the environment before the implementation of the ACA as the "full information" case, thus $\mathcal{I} = (j, e, k_j, z_{j,e,m_{j-1}}, m_{j-1}, g_j)$. Since the medical expenditure shock is given by a Markov process, $\Omega(m_j|m_{j-1}, j)$, insurers only need to know (m_{j-1}, j) to price premiums. Expected medical expenditures above the deductible are

$$EM(m_{j-1}, j) = \int_{m_j} max\Big\{0, m_j - d\Big\}\Omega(m_j|m_{j-1}, j) \tag{1.12}$$

Households and insurers play a two-stage game. In the first stage, agents declare a desired coverage rate, q_j, for medical expenses above a deductible, d. Second, a continuum of health insurers simultaneously post prices, $p(q_j, \mathcal{I})$, in an auction and are committed to delivering the desired amount of coverage in the event that their bid is accepted. In equilibrium consumers will accept the lowest price offered. Thus emerges a pricing schedule, which allows households to understand how the size of their desired coverage rate and medical expenditure risk affect their premiums. This Bertrand competition, along with assumption of risk neutral insurers, yields a zero profit condition for insurers and the break-even premium in the individual market can be written as

$$p(q_j, \mathcal{I}) = \gamma EM(m_{j-1}, j)q_j + \eta \tag{1.13}$$

where γ is the administrative load, which pays the cost of administering the health insurance plan, and η is a fixed cost of underwriting. Note, the desired level of coverage does not influence the insurers' expectation of medical expenditures.

The ESHI group market creates a risk sharing pool for all those who accept their ESHI offer. Since the coverage rate of group insurance is exogenous, subject to the same zero profit condition, premiums in the group market can be written as

$$p_g = \frac{\gamma q_g \Big(\int \mathbf{1}_{\{q_j = q_g\}} EM(m_{j-1}, j) d\Gamma(x) \Big)}{\int \mathbf{1}_{\{q_j = q_g\}} d\Gamma(x))} \tag{1.14}$$

where the numerator is total expected medical expenses above the deductible of the ESHI group insurance participants and the denominator is total number of ESHI group participants. Due to that absence of individual underwriting in the group market the premium does not include a fixed cost of underwriting.

Post-ACA Premium Pricing

Now I turn to the post-ACA, "partial information" environment, which is the setting where insurers are no longer able to condition premiums in the individual market on medical history. I assume the pricing of the ESHI group premium remains unchanged. Per law, premiums in the post-ACA individual market can be conditioned on age, j. Under the single risk pool arrangement, which is the baseline post-ACA scenario, expected medical expenditures cannot be conditioned on desired coverage level, q_j. Under the single risk pool the information set of insurers is then $\mathcal{I} = (j, \mathbf{1}_{q_j \in IND})$, where $\mathbf{1}_{q_j \in IND}$ is an indicator variable for choosing any plan offered in the individual market. In a counterfactual experiment I allow the insurers to form separate risk pools according the desired coverage level. Under the separate risk pool arrangement, expected medical expenditures are conditioned on the desired level of coverage, q_j. The information set available to insurers to price premiums is then $\mathcal{I} = (j, q_j)$.

Given the Markov chain specification for the evolution of medical expenditure shocks, $\Omega(m_j|m_{j-1}, j)$, with asymmetric information the problem of the insurer is to try to infer the value of m_{j-1} given the information set, $\mathcal{I}$. Recall that the stationary joint distribution is defined as $\Gamma(j, e, k_j, z_{j,e,m_{j-1}}, m_{j-1}, g_j)$ and let the decision rule for the coverage rate be defined as $q_j = f_q(j, e, k_j, z_{j,e,m_{j-1}}, m_{j-1}, g_j)$. Let $S(m_{j-1}|\mathcal{I})$ be the set of values for $(e, k_j, z_{j,e,m_{j-1}}, g_j)$ that for a household with given m_{j-1} are consistent with $\mathcal{I}$ and the decision rule, $f_q(x)$. Here we can see how the heterogeneity of households over income, wealth, and education, obscures the information about medical expenditure risk contained in the signal of desired coverage level. Let $Pr(m_{j-1}|\mathcal{I})$ denote the probability of an individual having current state m_{j-1} conditional on the observable information and knowledge of the household's decision rule $q_j = f_q(x)$. In a stationary equilibrium, the conditional probability of a household having m_{j-1} can be written as

$$Pr(m_{j-1}|\mathcal{I}) = \int_{S(m_{j-1}|\mathcal{I})} d\Gamma(j, e, k_j, z_{j,e,m_{j-1}}, m_{j-1}, g_j) \tag{1.15}$$

With this conditional probability the insurer computes expected medical expenditures above the deductible as

$$EM(\mathcal{I}) = \int_{m_{j-1}} \left[\int_{m_j} max\Big\{0, m_j - d\Big\}\Omega(m_j|m_{j-1}, j)\right] Pr(m_{j-1}|\mathcal{I}) \tag{1.16}$$

The break even premium in the individual market can be written as

$$p(q_j, \mathcal{I}) = \gamma EM(\mathcal{I}) q_j + \eta \tag{1.17}$$

The differences in the pricing of premiums before and after the implementation of the ACA can be seen by comparing equations (1.13) and (1.17). In the "partial information" setting with separate pooling, the expected medical expenses are a non-linear, increasing function of the desired level of coverage, $EM(j, q_j)$. With separate pools, the desired coverage level informs the insurers' beliefs of medical expenditure risk. In contrast, the regulation of a single risk pool requires that insurers hold the same beliefs about medical expenditure risk across all enrollees of the same age, $EM(j, \mathbf{1}_{q_j \in IND})$. With a single pool the ratio of premiums across plans is a constant fraction equal to the ratio of coverage levels.[14] Conversely, in the "full information" pre-ACA setting, expected medical expenses depend only on age and medical history,

[14]Since underwriting is forbidden under the ACA, the fixed cost, η, goes to zero and the ratio of a premium for a plan offering a higher coverage level to that of a low coverage level is equal to the ratio of the coverage levels, i.e. $\frac{p(q_j^H, j)}{p(q_j^L, j)} = \frac{\gamma EM(j, \mathbf{1}_{q_j \in IND}) q_j^H}{\gamma EM(j, \mathbf{1}_{q_j \in IND}) q_j^L} = \frac{q_j^H}{q_j^L}$.

$EM(m_{j-1}, j)$. For a detailed description of the calculation of post-ACA premium prices off the equilibrium path, consult the appendix.

1.2.4 Production Sector

Output is produced by two competitive firms, one of which offers ESHI. Capital is freely allocated across the two firms. Given this set up, production can be described by a single representative firm. Production occurs according to a constant returns to scale, Cobb-Douglas production function, $Y = AK^{\alpha}L^{1-\alpha}$. A is total factor productivity, K is aggregate capital, and L is aggregate effective labor. The firms' profit maximization problem can be written as

$$\max_{K,L} Y - wL - (r + \delta)K \tag{1.18}$$

where δ is the depreciation rate, r is the rental rate, and w is wage per effective unit of labor. Solving the maximization problem yields the equilibrium prices,

$$w = (1 - \alpha)AK^{\alpha}L^{-\alpha} \tag{1.19}$$

$$r = \alpha AK^{\alpha-1}L^{1-\alpha} - \delta \tag{1.20}$$

The labor and capital market clearing conditions are

$$K = \int k_j d\Gamma(x) \quad and \quad L = \int_{j<j^*} z_{j,e,m_{j-1}} l_j d\Gamma(x) \tag{1.21}$$

For the firm that does not offer ESHI, $\widetilde{w} = w$. That is, workers are paid their marginal product of labor. Following Jeske and Kitao (2009), in order for the ESHI offering firm to finance its share of the group premium, μ, it subtracts an amount c_E from the marginal product per effective unit, $\widetilde{w} = w - c_E$. The zero profit condition on firms gives the contribution as

$$c_E = \frac{\mu p_g \int \mathbf{1}_{\{g_j=1 \text{ and } q_j=q_g\}} d\Gamma(x)}{\int l_j z_{j,e,m_{j-1}} \mathbf{1}_{\{g_j=1\}} d\Gamma(x)} \tag{1.22}$$

where the numerator is the total contributions paid by the ESHI offering firm and the denominator is the total effective labor working in the ESHI offering firm.

1.2.5 Government

Prior to the ACA the role of the government is to operate the Social Security, Medicare, Medicaid, and social assistance programs via revenues from the income, payroll, and consumption taxes. Tax revenues and outlays for the various transfer programs can be summarized by

$$\begin{aligned} Revenues &= \int_x Tax(x) + \tau_c c_j d\Gamma(x) \\ Medicare &= \int_x (q_{mcr} m_j - p_{mcr}) d\Gamma(x|j \geq j^*) \\ Medicaid &= \int_x q_{mcd} m_j d\Gamma(x|y_j < y_{mcd}) \\ Social\ Security &= \int_x ss_e d\Gamma(x|j \geq j^*) \\ Social\ Assistance &= \int_x T_{SI} d\Gamma(x) \end{aligned} \tag{1.23}$$

I assume the government cannot borrow, so its intratemporal budget constraint is

$$Revenues = G + Social\ Security + Medicare + Medicaid + Social\ Assistance \tag{1.24}$$

where G is exogenous government spending, which does not directly enter the household's utility function.

1.2.6 Other Model Changes Due to ACA

In addition to the changes in premium pricing described previously, the ACA also entails other changes to the model. While in the pre-ACA setting individuals can purchase any level of coverage they prefer, i.e. $q_j \in (0, 1]$, per the law plans offered on the age-adjusted community rated exchanges must cover at least 60% of medical expenses on average. The choice set for coverage level is now restricted to $q_j \in [0.6, 1]$.

Following the implementation of the ACA, those who go uninsured must pay a penalty, $Pen(y_j)$, equal to 2.5% of income or \$695, whichever is larger. Households are exempt from the penalty if the Bronze premium exceeds 8% of their income. For individuals whose premium may be financially burdensome, the ACA stipulates the provision of a premium subsidy, $Sub(y_j)$, conditional on income. The subsidy is only provided to cover Silver level plans. In practice, the ACA provides the premium subsidy no matter which plan is chosen and provides an additional cost-sharing subsidy for low income households who choose the Silver plan. For my model I adopt a simpler framework where I combine both subsidies into a premium subsidy that is only available to households selecting Silver plans. The size of the subsidy ensures that the Silver premium does not exceed a certain share of income, where the share decreases as income gets further from the federal poverty line (FPL). The subsidy scheme is summarized in Table (1.1).

Table 1.1: Premium Subsidies in Post-ACA Individual Market

Income (as % of FPL)	**Maximum Premium (% of Income)**
<133%	2%
133%-150%	3%-4%
150%-200%	4%-6.3%
200%-250%	6.3%-8.05%
250%-300%	8.05%-9.5%
300%-400%	9.5%

The budget constraint of the working age household becomes

$$\begin{aligned}(1+r)k_j + \widetilde{w}z_{j,e,m_{j-1}}l_j + T_{SI} + B_e + Sub(y_j) \geq \\ k_{j+1} + (1+\tau_c)c_j + O(m_j, q_j) + Tax + p + Pen(y_j)\end{aligned} \tag{1.25}$$

After the implementation of the ACA, the government earns a new source of revenues through the penalties on the uninsured and faces new outlays, in the form of the subsidies and additional Medicaid transfers. Medicaid eligibility is increased up to 133% of the FPL. Post-ACA, the government's revenues increase by $\int_x Pen(y_j)d\Gamma(x)$ and outlays increase by $\int_x Sub(y_j)d\Gamma(x)$ and some amount for Medicaid. The ACA also entails the creation of a new 39.6% marginal tax bracket for income above \$450,000 (2013\$). More details on the progressive income tax code can be found in the calibration section. In the counterfactuals I experiment with the removal of the penalty, subsidy, and public insurance expansion.

1.2.7 Perfect Bayesian Equilibrium for Signaling Game

I begin with a description of the equilibrium for the post-ACA individual insurance market game and then proceed to a description of the stationary competitive equilibrium of the full model. Since I developed a signaling game of incomplete information, I can utilize the notion of Perfect Bayesian Equilibrium as my equilibrium concept. Recall, the abbreviated state space for household's state variables is $x = (j, e, k_j, z_{j,e,m_{j-1}}, m_{j-1}, g_j)$, and the stationary joint distribution of households over the state space is $\Gamma(x)$. Under the single risk pool the information set is $\mathcal{I} = (j, \mathbf{1}_{q_j \in IND})$. With separate risk pools, the information set of insurers is $\mathcal{I} = (j, q_j)$. I define $\Psi(x, q_j)$ as the stationary equilibrium joint distribution of households and their desired coverage rate, as determined by the decision rule for the coverage rate, $q_j = f_q(x)$, and the distribution of households over the state space, $\Gamma(x)$. Denote $\varphi(q_j)$ as the fraction of households age j who demand a level of coverage q_j and $\Upsilon(x|q_j)$ as the common beliefs of insurers on the household's state, conditional on a desired level of coverage.

A perfect Bayesian equilibrium for the game of incomplete information between insurers and households is such that given the household's decision rule on insurance coverage, $q_j = f_q(x)$, insurers' strategy for premium pricing, $p(q_j, \mathcal{I})$, and insures' common beliefs, $\Upsilon(x|q_j)$, the following conditions are satisfied: (1) Given the price function for premiums, $p(q_j, \mathcal{I})$, the decision rule, $q_j = f_q(x)$, maximizes household's utility. (2) Given common beliefs, $\Upsilon(x|q_j)$, the price function for premiums, $p(q_j, \mathcal{I})$, is the pure strategy Nash equilibrium for the one-shot auction where insurers post simultaneous premiums in response to households coverage rate bid, q_j. (3) For any q_j such that $\varphi(q_j) > 0$, the common beliefs of insurers, $\Upsilon(x|q_j)$, are derived from $\Psi(x, q_j)$ and $q_j = f_q(x)$ using Bayes' rule.

Multiplicity of equilibria is common in signaling games of asymmetric information because the definition of a perfect Bayesian equilibrium does not discipline off equilibrium path, i.e. $\varphi(q_j) = 0$, beliefs (see Cho and Kreps, 1987). Since the insurance decision requires that consumers know what prices they would face at every coverage level, the off equilibrium path beliefs of the insurer determine which equilibrium I select. A number of refinements for perfect Bayesian equilibrium are available to determine if the equilibrium I have selected is supported by reasonable off equilibrium path beliefs. For a discussion of iterative procedure for computing the Bayesian equilibrium and its construction of the off equilibrium beliefs see the appendix. Based on the Intuitive Criterion, the off equilibrium path beliefs induced by my iterative solution procedure seem reasonable.

1.2.8 Competitive Equilibrium

The description of the stationary competitive equilibrium is as follows. Given the parameters that define social assistance, Medicare, Medicaid, and Social Security, $\{\underline{c}, q_{mcd}, y_{mcd}, p_{mcr}, q_{mcr}, \overline{y}_{ss}\}$, the coverage rate for ESHI group insurance before and after the ACA, q_g, a deduction from ESHI labor's wage, c_E, and the ESHI offering firm's share of the group premium, μ, the competitive equilibrium for this economy consists of time invariant prices $\{w, r, p_g\}$ and price function $p(q_j, \mathcal{I})$, decision rules $\{l_j(x), q_j(x), c_j(x), k_{j+1}(x)\}$, and tax functions $\{T(y_j), \tau_y, \tau_c, \tau_{ss}, \tau_{mcr}\}$ such that the following conditions are satisfied:

1. Given the set of time invariant prices and tax rates, the decision rules of the household solve the optimization problems, equations (1.4) and (1.8).
2. The wage, w, and the rental rate, r, satisfy the firm's maximization problem, equation (1.18), and the capital and labor markets clear, equation (1.21).
3. The deduction from wages of the ESHI group, c_E, satisfies equation (1.22) and the ESHI offering firm earns zero profits.
4. The group premium, p_g, satisfies equation (1.14) and the individual premium, $p(q_j, \mathcal{I})$ is the Nash equilibrium of the insurers' game and satisfies equations (1.13) and (1.17) such that insurers earn zero profits.
5. The tax functions $\{T(y_j), \tau_y, \tau_c, \tau_{ss}, \tau_{mcr}\}$ balance the government's intratemporal budget constraint.

6. By Walras' Law the goods market clears.

1.3 Data and Calibration

1.3.1 Data Source

In order to calibrate the model I utilize the Medical Expenditure and Panel Survey (MEPS) from the Department of Health and Human Services' Agency for Healthcare Research and Quality. The longitudinal component of the survey consists of two-year panels and for each year tracks demographics, income, insurance status, employment, and out-of-pocket and total medical expenditures. I pool ten waves of the MEPS dataset from 2000-2010. In order to conform to the structure of the model I drop all participants who are under the age of 25 or report negative labor income.

While the dataset links participants into Household Insurance Eligibility Units (HIEU) according to eligibility for a family plan, the MEPS does not identify the head of the household. Since my model abstracts away from family composition, I utilize a series of criteria to determine the head of the HIEU, which is equivalent to the notion of a household in my model. First, the member of the HIEU with the highest income is assigned as head. If that criterion fails to identify a single individual as head I then select the oldest individual with the highest income. If the second criterion fails, I select the oldest male with the highest income. These three criteria are sufficient to identify all the heads of the HIEUs. Doing so yields 60,408 observations.

To compute aggregate statistics I utilize the longitudinal weights provided by the MEPS. All prices are normalized to 2008 using the Consumer Price Index for all Urban Consumers (CPI-U).

1.3.2 Calibration

Demographics

Households begin their lives at age 25. They have 40 years to potentially work then retirement is exogenously enforced at age 65, j^*. A time period in the model is equivalent to one year. The maximum lifetime of a household is limited to 99 years. Individuals of age $j-1$ survive to age j with probability $\psi_{j,m_{j-1}}$, which depends on their age and last period's medical shock. To calibrate these survival probabilities, I use a method similar to Attansio et al. (2011) and Pashchenko and Porapakkarm (2012). Using the longitudinal waves of the MEPS I can observe whether individuals survive from year to year (variable DIED). I estimate survival probability using a probit regression over age, gender, a binary indicator for whether the previous medical shock crossed a certain threshold, and education. I then compute the average of the predicted values by age and the binary indicator for the medical shock using the longitudinal weights. To test the validity of these estimates I compute the weighted average of survival probabilities across medical shocks and compare the results to the Social Security Life Tables and find a close match.

Individuals in my model are endowed with education, $e \in \{0, 1, 2\}$, at the start of their lives. $e = 0$ signifies less than a high school degree (16% of sample), $e = 1$ signifies a high school degree or GED equivalent (53% of sample), and $e = 2$ signifies a college, technical, or graduate degree (31% of sample). The MEPS reports the highest degree received by the respondent upon entering the survey (variable HIDEGYR).

From the Census Bureau's Current Population Survey for 2008, I calculate the population age 65 and above as a share of the population over age 25 at around 20%. Matching the relative shares of working age and retired in the model to the data requires a population growth rate of 1.8%.

Insurance

In the MEPS, insurance status is reported on a monthly basis. To determine insurance status as it is defined in the model, i.e. on an annual basis, I sum up the total number of months that the household reported having group, individual, or public (Medicaid) insurance (variables PEGmm, PRImm, and PUBmm, respectively). If the household reports having the same type of health insurance for six months or more, they are assigned to that category. If the household reports less than six months of any insurance, but private (group or individual) and public combined has more than six months coverage, then they are assigned as having public insurance. Otherwise the household is assigned as uninsured.[15]

[15] To test the calibration's sensitivity to this specification for health insurance status (6 months), the procedure was repeated for periods as short as 4 months and as long as 8 months. The relative shares across categories did not vary significantly across the cases suggesting few cases of intra-annual

Recall that in the pricing of premiums γ is the administrative load on premiums and η is a fixed cost of underwriting. An analysis by the Congressional Budget Office (CBO) finds that the administrative load in the group market varies by the size of the firm, ranging from 7% for firms with at least 1,000 employees to 25% for firms with 25 or fewer employees.[16] For the group market I choose the national average of 12%, $\gamma = 1.12$, and a fixed cost of $\eta = \$0$, since underwriting does not occur on an individual basis in the group market. According the same CBO report, administrative loads in the individual insurance market closely resembles those of the small group market, ranging as high as 30%. I chose an administrative load of 25%, $\gamma = 1.25$, for the individual market. I use the fixed cost of underwriting to target the share of working age population enrolled in the individual market, which produces a value of $\eta = \$604$. For the post-ACA setting, the law stipulates that the markups in the community-rated individual market not exceed 15%. In the post-ACA setting I set the administrative load of the individual market equal to the group, $\gamma = 1.12$.

Since the probability of receiving an ESHI offer is exogenous, I match the aggregate share of working age households with ESHI by adjusting the share of the ESHI premium covered by the employer, μ. The resulting figure $\mu = 76\%$ is consistent with the average employer contribution of 81% found in previous surveys (Kaiser Family Foundation, 2009).

The exogenous coverage rate in the group market, q_g, is set to 80%. As shown in Figure (A.2), with a median of 80% the group market offers high coverage rates relative to the individual market. In order to generate the large mass of individuals in the left tails of Figure (A.2), i.e. those reporting little to no cost sharing, I set the deductible, d, equal to \$1000, which is the average level recorded in Kaiser Family Foundation survey. Problematically, the survey also finds substantial variation in deductibles depending on whether the plan belongs to an HMO or PPO and whether it is an ESHI or individual plan.[17]

To ease the computational burden, the choice set for coverage rates in the

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switching across categories.

[16] Congressional Budget Office, Dec. 2008, Key Issues In Analyzing Health Insurance Proposals, `https://www.cbo.gov/sites/default/files/cbofiles/ftpdocs/99xx/doc9924/12-18-keyissues.pdf`

[17] Issues surrounding the calibration of the deductible are discussed in the next section.

individual market is discrete and separated by 10% intervals. In the pre-ACA setting the choice set for coverage rates above the deductible is $q_j \in \{10\%, 20\%, 30\%, ..., 80\%, 90\%, 100\%\}$. As stipulated by the ACA the choice set in the post-ACA environment is restricted to be above 60% and becomes $q_j \in \{60\%, 70\%, 80\%, 90\%\}$. $q_j = 60\%$ corresponds to a Bronze plan, $q_j = 70\%$ to the Silver plan, $q_j = 80\%$ to the Gold plan, and $q_j = 90\%$ to the Platinum plan. Choosing $q_j = 0\%$ corresponds to going uninsured. While the ACA rates plans based on the share of essential health benefits covered by the policy, I abstract away from this distinction and assume the plans cover all medical expenses.[18]

Medical Expenditures

For the calibration of medical expenditures, I follow the method of Pashchenko and Porapakkarm (2012). The MEPS records total medical expenditures (variable TOTEXP) and the concept is identical to the model's definition, i.e. the sum of the household's total out of pocket expenses and the payments made by insurer. I begin by separating the dataset into 13 age groups each with a five year span, i.e. 25-29, 30-34,..., 80-84, 85+. Within each age group I calculate the percentiles for the medical expenditures. Since in the model I am approximating the medical expenditure shock by a 5-state Markov process, $\Omega(m_j|j, m_{j-1})$, I create five bins for each age group corresponding to the (0-30th), (30th-60th), (60th-90th), (90th-99th), and (99th-100th) percentiles of total medical expenses, which are named Med=1, Med=2, Med=3, Med=4, and Med=5, respectively. The intervals are chosen in this fashion to capture the right-skewed distribution of medical expenditures at each age. In each bin I calculate the average of medical expenditures and assign that value to average age of the group, i.e. 27, 32,..., 82, and 87. To fill in the values for the missing ages I fit a cubic function of age across the assigned averages for each bin. The relative

[18]Per the law, essential health benefits are defined as medical expenses "including items and services within at least the following 10 categories: ambulatory patient services; emergency services; hospitalization; maternity and newborn care; mental health and substance use disorder services, including behavioral health treatment; prescription drugs; rehabilitative and rehabilitative services and devices; laboratory services; preventive and wellness services and chronic disease management; and pediatric services, including oral and vision care.", `https://www.healthcare.gov/glossary/essential-health-benefits/`

values of the medical shocks are shown in Figures (A.5) and (A.6) in the appendix.

The binary indicator for the medical shock is determined by whether the size of the household's medical expenditures is above or below a certain threshold, $\overline{m}$. I assign the cutoff at the 90th percentile of medical expenditures for each age. Thus, $m_j \in \{1, 2, 3\}$ corresponds to low medical shocks and $m_j \in \{4, 5\}$ corresponds to high medical shocks.

To determine the transition probabilities of the Markov process, I repeat the procedure above for each of the two years in the MEPS' longitudinal waves. The transition probability between medical expense bins is equal to the share of households that make said move from one year to the next. I calculate the transition probability matrices for working age (25-64) and retired households (65+) separately. The transition matrices are shown in Tables (A.1) and (A.2) in the appendix.

The MEPS underreports the size of medical expenditures. The bias is more severe at older age groups as the survey suffers from selection bias in the form of attrition. The MEPS does not track institutionalized individuals or those in hospice. According to the National Health Expenditure Account, during the 2000-2010 period medical expenses averaged 15.6% of GDP. To match medical expenses to their aggregate share I scale up working age households' expenses by a factor of 1.18 and retired households' by a factor of 1.93. The higher scale factor for the retired reflects the observation from the MEPS data that while those above age 65 only account for 20% of the population, they account for approximately half of all medical spending because of the escalation of medical expenditure risk with age.

Labor Income

Productivity is given by $z_{j,e,m_{j-1}}$, which is the log sum of a deterministic term, $\lambda_{j,e,m_{j-1}}$, and two shocks. One shock, υ_j, is a persistent AR(1) process while the other, ζ_j, is white noise. The value of the parameters governing the AR(1) and white noise processes are copied from the existing incomplete markets, life-cycle literature. ρ, the parameter controlling the persistence of the AR(1) process, is set to 0.98 and the variance of its innovations, σ_z^2, is set to 0.018, consistent with the estimates of Storesletten et al (2004), Hubbard et al (1994), Erosa et al (2011), and French (2005). To construct the initial AR(1) shock, υ_1, I follow Heathcote et al. (2010), and draw the shock from a $N(0, 0.124)$ distribution. I set the variance of the white noise process, σ_{ζ}^2, to 0.1, following Erosa et al. (2011). For the computational procedure I discretize the two shocks by the method of Floden (2008). For the white noise process I use two grid points and for the AR(1) process I use nine grid points. The values at the grid points of υ_j are expanding exponentially. The expanding grid points capture the large cross-sectional variation in income, and were chosen to match the right-skewed income distribution at each age, i.e. the small mass of individuals earning very high labor incomes.

The deterministic term, $\lambda_{j,e,m_{j-1}}$, which is a function of age, education, and the binary indicator for medical expenditure shock, determines the mean of income at each age. As observed in the MEPS data, higher educational attainment generates a steeper hump in agents' productivity profile over their life cycle. To calibrate this function I employ the method of French (2005). Since the implementation of the ACA portends changes for labor market participation, the accuracy of the model's predictions depend on the labor productivity profile of unemployed households, who are not observed in the MEPS. Problematically, while the observed labor income profile of high and low medical expenditure shock workers is similar in the MEPS data their labor force participation rates vary significantly across all ages. If the productivity of high medical risk workers is on average lower than low medical risk workers but only the most productive high risk workers participate in the labor force, the estimation of the high risk workers' productivity would have a positive selection bias.

By the method of French (2005), I begin by measuring labor income from the MEPS dataset. I define labor income as wage income (variable WAGEP) plus 75% of business income (BUSNP), which is common in the macroeconomic literature. The deterministic term, $\lambda_{j,e,m_{j-1}}$, is approximated by a cubic function separately for each medical expenditure and educational group. Determining the four coefficients of the cubic function requires four moments. The moments I choose are the average incomes of each education group at ages 25, 40, 50, and 64.

I begin by constructing an initial guess of $\lambda_{j,e,m_{j-1}}$ and solving the decision rules of the model. I then simulate the households' distribution and compare the average simulated labor income from the model to the estimates from the MEPS data. The coefficients of $\lambda_{j,e,m_{j-1}}$ are then updated, (i.e. raised or lowered depending on whether the initial guess was below or above the MEPS income estimate, respectively) and the solution procedure repeats. As with the other prices in the model, this process is repeated until the guess of $\lambda_{j,e,m_{j-1}}$ converges to within a specified tolerance.

Employment

The labor choice set of the working age household is $l_j \in \{0, l_{PT}, l_{FT}\}$. I set the labor supply of part-time and full-time workers to be $l_{PT} = 0.2$ and $l_{FT} = 0.4$, respectively. The MEPS dataset records the average weekly hours worked by respondents (variables HOUR1-HOUR5) and their labor earnings (discussed above). I define a part-time worker as an agent who worked on average at least 10 to 30 hours per week and made at least the federal minimum wage of \$5.15/hour, i.e. \$2,678/year. I define a full-time worker as an agent who worked on average at least 30 hours per week and made at least federal minimum wage, i.e. \$8,034/year.

I match the employment rates by age group, education, and the binary indicator for medical expenditure shock by adjusting the fixed cost to leisure, ϕ_{j,e,m_j}. The fixed cost to leisure is given by $\phi_{j,e,m_j} = \phi_1(e) + \mathbf{1}_{\{m_j > \overline{m}\}}\phi_2(j,e)$. The first component, $\phi_1(e)$, applies to households of both high and low medical expenditures and does not vary with age. For each educational group $\phi_1(e)$ is calibrated to match the employment rate of the 55-59 year old age group. The second component, $\mathbf{1}_{\{m_j > \overline{m}\}}\phi_2(j,e)$, only applies to individuals with high medical expenses and is a linear function of age. The intercept and slope of the line are calibrated to match the employment rates of the 25-29 and 55-59 year old age groups. A summary of the calibration of the fixed cost to leisure parameter can be found in Table (1.2).

Table 1.2: Calibration of Fixed Cost to Leisure

Education	$\boldsymbol{\phi_1(e)}$	$\boldsymbol{\phi_2(25, e)}$	$\boldsymbol{\phi_2(64, e)}$
Less than High School	0.1400	0.1775	0.1250
High School or GED	0.1425	0.1425	0.1250
College or more	0.1175	0.0000	0.1500

ESHI Offer

For the calibration of the exogenous ESHI offer I follow Pashchenko and Porapakkarm (2012) and assume the likelihood of getting an offer is given by a logistic function of the form:

$$Pr(g_j = 1) = \frac{exp(\omega_j)}{1 + exp(\omega_j)} \tag{1.26}$$

where ω_j is an odds ratio determined by the following linear regression:

$$\omega_j = \beta_0^e + \beta_1^e log(inc_j) + \beta_2^e log(inc_j)^2 + \beta_3^e log(inc_j)^3 + \beta_4^e \mathbf{1}_{\{g_{j-1}\}} + \Theta^e D_j \tag{1.27}$$

inc_j is labor income at age j, normalized by the average labor income across all ages, and D_j is a set of year dummies that capture time and trend effects. The preceding regression was run on each education category, and thus the coefficients, $(\beta_1^e, \beta_2^e, \beta_3^e, \beta_4^e, \Theta^e)$, are education specific.

Government and Public Insurance

In order to finance expenditures, the government collects revenues through five different forms of taxation: a progressive income tax, two payroll taxes, a consumption tax, and a proportional income tax. Working and retired household's are subject to a progressive tax, $T(y_j)$, on all income. The structure of the progressive income tax is taken from the 2008 federal income tax code and is summarized in Table (1.3). The brackets and rates of the federal progressive income tax were changed under the Economic Growth and Tax Relief Reconciliation Act of 2001 and remained almost unchanged over the sample period taken from the MEPS, 2000-2010. Consistent with the federal tax code I allow a deduction of \$9,000 from taxable income to account for the standard deduction of \$8,000 in 2008 and \$1,000 for personal deductions, i.e. mortgage and student loan interest, child tax credit, marriage credit, etc.

Per law, the government charges Social Security, τ_{ss}, and Medicare, τ_{mcr}, payroll taxes of 12.4% and 2.9%, respectively, to individuals of working age. While in practice these taxes are split between employer and employee, I ignore this distinction and specify that the employee pay the full tax rate. Per law, the payroll tax for Social Security is only charged on the first \$102,000 of income, $\overline{y}_{ss}$. The government also

Table 1.3: Progressive Income Tax Brackets in 2008 (2008$)

Marginal Tax Rate	**Income Bracket ($)**
10%	0 - 11,450
15%	11,450 - 43,650
25%	43,650 - 112,650
28%	112,650 - 182,400
33%	182,400 - 357,700
35%	357,700+
39.6% (Post-ACA only)	435,000+ (2013$)

collects taxes on consumption, τ_c, equal to 5.67%. This tax reflects the widespread use of sales tax at the state and local level. The level of the consumption tax was chosen to match the consumption tax's revenue as a share of total tax revenue in the NIPA data.

In order to balance the government's intratemporal budget constraint in both the pre-ACA and post-ACA settings, I adjust the proportional income tax rate, τ_y. Proportional income taxation enjoys widespread use at the state level, as only seven of the fifty states do not have one. State income taxes are also significantly less progressive than the federal tax code. In equilibrium the proportional income tax rate in the pre-ACA model is 9.8%.

In practice, the size of the social security transfer received in retirement is a function of a household's average earnings over the last 35 years of employment. To avoid the difficulty of tracking the income of every agent over their lifetime I adopt a simpler framework where the transfer is a fraction of the average annual income of each education group from ages 30 to 64. The social security payments to retired persons are given by

$$ss_e = repl_e * AIME_e \tag{1.28}$$

where $repl_e$ is the replacement rate, which is the fraction of $AIME_e$, the average annual income of all working households age 30 to 64 in each education group, that is transferred by the government during retirement years. According to a Social Security Administration report, the replacement rates of each education group are 80% for less than high school, 60% for high school or equivalent, and 40% for college and above.[19] The higher replacement rate for lower income individuals reflects the progressivity of the Social Security benefits formula.

Exogenous government expenditures, G, are set to 19.5% of GDP, based on average spending levels recorded in the BEA's NIPA tables for the years 2000 to 2010.

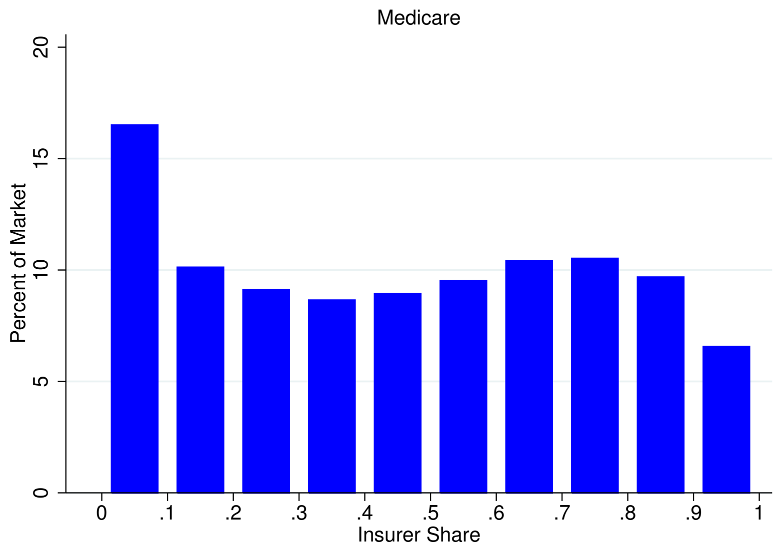
From the MEPS data, the average coverage rate for Medicaid is 82.7% and is skewed right. The Medicaid program is very generous in covering medical expenses due to the limited financial means of its participants. For this reason, the coverage rate for Medicaid, q_{mcd}, is set to 90%. Per law Medicaid has no premium. Eligibility for Medicaid varies by state. Weighting each state's income eligibility for Medicaid in 2008 by state population yields a national average 88.8% of the Federal Poverty Line. Because Medicaid also requires categorical eligibility, i.e. single parent, disability, etc., I set the income threshold for Medicaid eligibility at 70% of the Federal Poverty Line for households under age 40, 88% for ages 40 to 54, and 90% ages 55 to 64. Relaxing the income eligibility with age reflects the fact that categorical eligibility increases in likelihood with age. The Federal Poverty Line for a head of household in 2008 is $10,400.

Based on the distribution of Medicare coverage rates observed in the MEPS dataset, shown in Figure (1.2), the coverage rate for Medicare, q_{mcr}, is chosen as the median of the distribution, 70%. Medicare premiums can vary by age, prescription plan (Part D), geographical region, and participation in traditional Medicare or Medicare Advantage (Part C). For simplicity, based on data from the National Health Expenditure Account (NHEA), the average Medicare premium equals 2.1% of GDP per capita. With a GDP per capita of $48,330 in 2008, the premium is $1,014.

The government in my model operates a social assistance program for working age and retired households that guarantees all agents receive a minimum level of consumption, $\underline{c}$, via a transfer, T_{SI}. The program is meant to represent the myriad of benefits provided to the poor and needy, such as Temporary Assistance to Needy Families, Social Security Disability Insurance, Supplemental Nutrition Assistance Program, etc. I set $\underline{c}$ at $3,500 based on the estimates of De Nardi et al. (2010).

[19] The replacement rates are from the U.S. Social Security Administration, Office of Retirement and Disability Policy, Alternate Measures of Replacement Rates for Social Security Benefits and Retirement Income, Table (1), Wage-Indexed Average Earnings, `http://www.ssa.gov/policy/docs/ssb/v68n2/v68n2p1.html`

Figure 1.2: Histogram of the Distribution of Cost Sharing in Medicare



Other Parameters

The depreciation rate of capital, δ, is set to 2.5%. α is capital's share of income, which is set to 0.33 consistent with U.S. data. Consumption's share of utility relative to leisure, χ, is set to 0.6. The parameter governing the intertemporal elasticity of substitution, σ, is set to 5.0 which yields a constant relative risk aversion of 3.4.[20] Total factor productivity, A, is chosen to normalize aggregate output to one in the pre-ACA setting. The discount factor, β, is chosen to target an aggregate capital to output ratio, K/Y, of 3, which yields a discount factor of 0.997.

[20] CRRA=$1 - \chi(1 - \sigma)$, the calibrated value of 3.4 is consistent with the findings of Halek and Eisenhauer (2001) who estimate a CRRA of 3.7 and Mankiw (1985) which finds estimates ranging from 1.8 to 5.3.

1.4 Pre-ACA Baseline Model Performance

1.4.1 Insurance Statistics

Table (1.4) provides a comparison of the aggregate insurance statistics taken from the MEPS dataset and the ones produced by the pre-ACA version of the model. As dictated by the calibration, the model performs well in matching the insurance status of the total population, the first pair of columns on the left. Recall from the calibration, the parameters for the fixed cost of underwriting individual insurance and the share of the ESHI premium covered by the employer were chosen to align the total shares for individual and group insurance. The baseline model performs well at matching the insurance shares across educational groups, as seen when comparing the last three pairs of columns in the table, despite not targeting these moments.

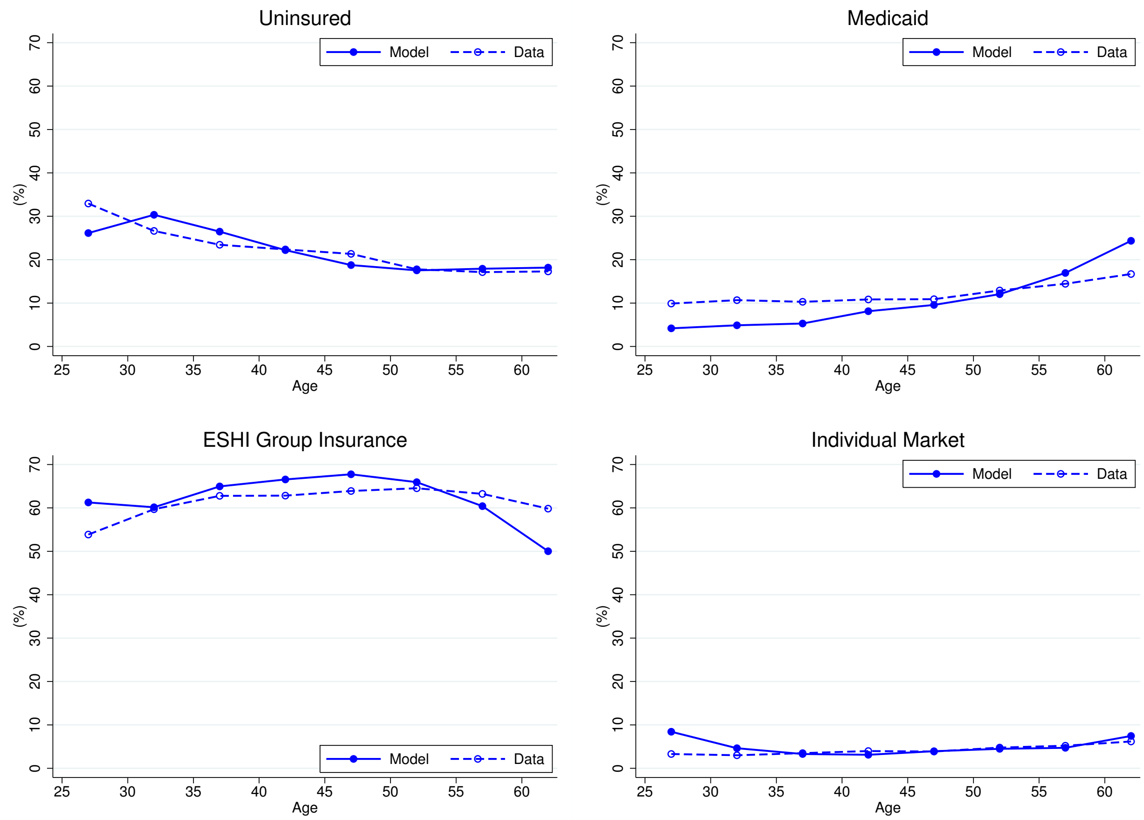
Table 1.4: Aggregate Statistics of Data and Baseline (Pre-ACA) Model

	Total		**Less than HS**		**High School**		**College & Up**	
	Data	Model	Data	Model	Data	Model	Data	Model
Uninsured	22.0	23.1	44.8	45.1	24.0	19.2	9.9	18.2
Medicaid	11.1	9.3	23.3	23.7	12.4	9.4	4.2	1.4
Individual	4.2	5.0	1.7	6.9	3.7	5.3	5.9	3.6
Group	62.7	62.6	30.2	24.2	59.9	66.1	80.1	76.8

Figure (1.3) provides a breakdown of insurance choice by age. The model does well at predicting the market shares of different insurance choices for all age groups. Medicaid participation is slightly under predicted at early ages and slightly over predicted at older ages. Simplifying eligibility for Medicaid to income only and abstracting away from the additional categorical criteria of the program, such as disabilities, is the likely cause of this discrepancy. Also, my model lacks borrowing, which encourages more households to work at younger ages. In turn, higher incomes preclude their eligibility for Medicaid.

Only at the youngest ages does the model tends to over predict participation in the individual market. Since I do not include borrowing or parental transfers in my model, if young households do not receive a group insurance offer or qualify for public assistance, then the individual market and the risk free asset are the only means of smoothing consumption due to medical shocks. The market share of ESHI

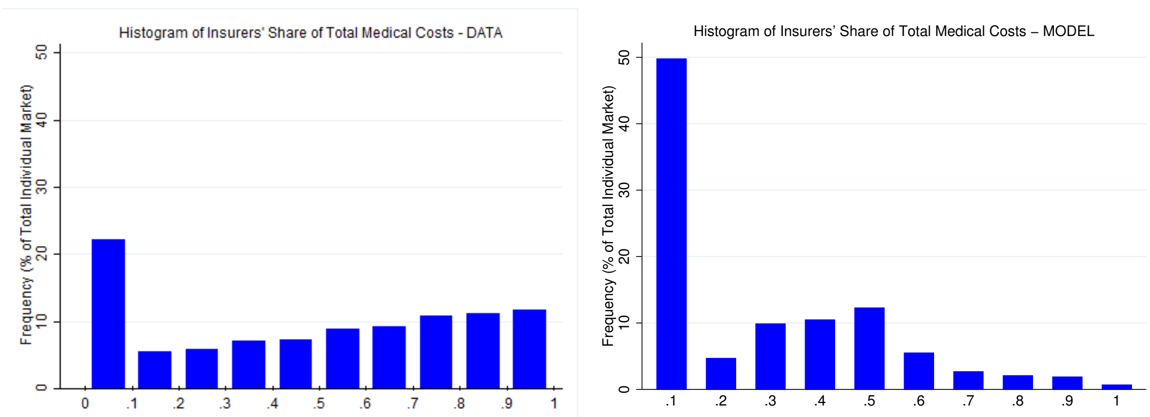
Figure 1.3: Insurance Status by Age, Pre-ACA Model versus Data



group insurance is slightly over predicted at early and mid ages. The elevated levels of group insurance are a consequence of the over prediction of employment rates, explained in the next section.

In the appendix of this paper I highlight several distinctions between the individual and group markets, namely the difference in the distribution of ex-post cost sharing rates. Figure (1.4) provides a comparison between the data, in the left panel, and the model results, in the right panel, of the ex-post total share of medical expenses covered by the insurer in the individual market. As observed in the data and the model, the presence of a deductible results in a significant portion of the market receiving nearly zero percent of their medical expenses covered. Because of underwriting the market is comprised primarily of lower risk individuals who are more likely to have medical expenses fall below the deductible. The left tail in the model is larger than the data because of the limitation of a single deductible level for all plans and ages. Data from the Kaiser Family Foundation shows a large variance in deductible levels.[21] In the ESHI group market, 77% of PPO plans have a deductible but only 28% of HMOs do. At firms with more than 200 workers, the average deductible for a PPO is $460, while for an HMO the average is $354. But at smaller firms, the average deductible for a PPO is $1,146, and $998 for an HMO. Conversely, in the individual market the average deductible for a PPO is $2,456 and for a HMO is $1,179.[22] Experimenting with very low deductible levels matches the size of the left tail produced in the model to the data. But these deductibles are far below what is observed in the data.

Figure 1.4: Histograms for the Share of Total Medical Expenses Covered by Insurer



1.4.2 Employment Statistics

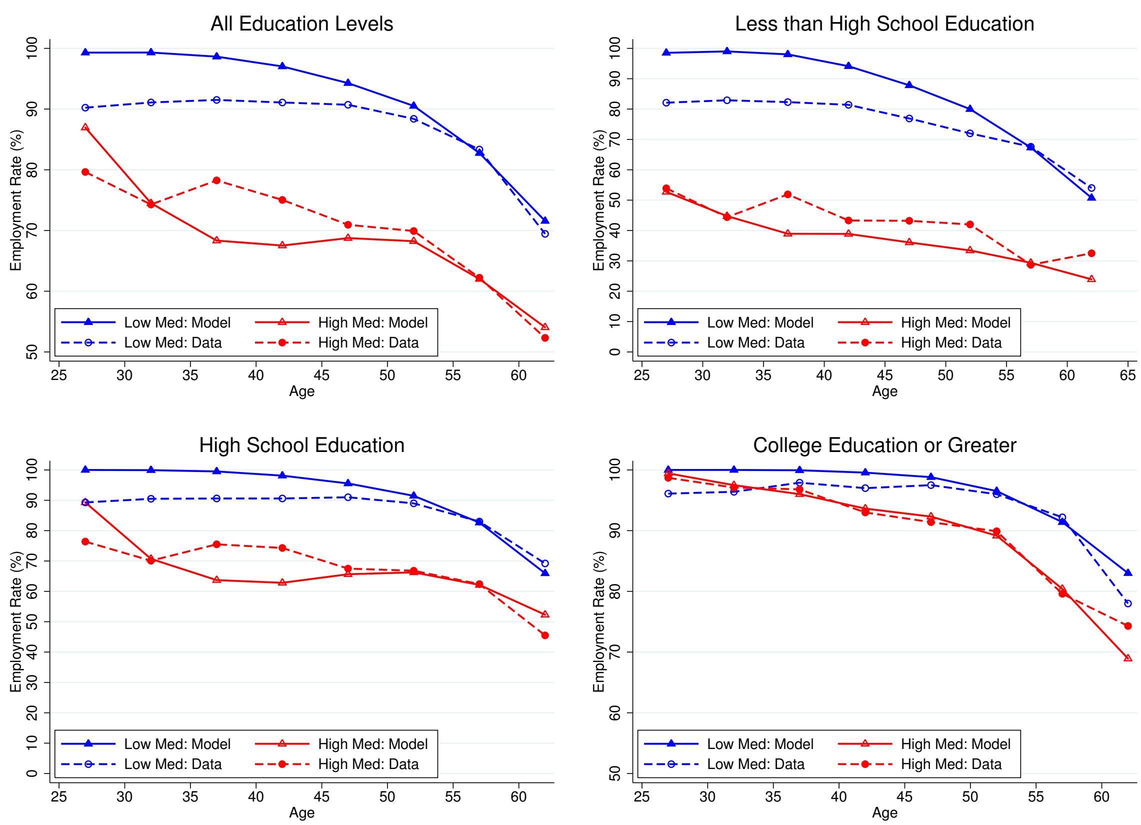
Figure (1.5) presents the employment rates for each educational group by age and the binary indicator for medical shock. Employment and labor force participation are equivalent in the model. The model provides a close match to the observed patterns in labor force participation, however the model over predicts the participation rate of younger households with low medical expenditure risk. The over prediction is a likely

[21] Kaiser Family Foundation, 2010 Annual Survey of Employer Health Benefits, `https://kaiserfamilyfoundation.files.wordpress.com/2013/04/8085.pdf`

[22] American Health Insurance Plans (AHIP), Individual Health Insurance 2009: A Comprehensive Survey of Premiums, Availability, and Benefits

consequence of the absence of borrowing and parental transfers in the model, both of which would delay labor force participation amongst younger individuals. The high employment rates observed in the data are a consequence of restricting the sample to household heads, as described in the calibration.

Figure 1.5: Insurance Status by Age, Pre-ACA Model versus Data



The model does a better job at matching the employment profile of households with high medical expenditure risk because the calibration was chosen to match this group. The calibration was chosen to match this group because these households are the ones most directly affected by the regulations of the ACA.

1.5 Results

This section analyzes the changes to the economy from the implementation of the ACA. Section 1.5.1 bolsters the validity of the calibration by comparing the post-ACA model with a partial penalty to early enrollment data, which covers a time period before the penalty was fully implemented. Section 1.5.2 analyzes the insurance market changes and general equilibrium effects of the reform. Section 1.5.3 focuses on the counterfactual where the single pooling arrangement is compared to the separate pooling arrangement. Section 1.6 analyzes the remaining counterfactuals, where each of the ACA's primary regulations is separately removed. All comparisons are between steady states and do not consider the transition period.

1.5.1 Comparison of Model to Early Enrollment Data

Little post-ACA enrollment data is available to judge the validity of the model's predictions. Furthermore, the post-ACA model represents an economy where households have lived under the ACA for their entire lives, not the transition periods. However some early enrollment data is available from the Department of Health and Human Services (HHS).[23] The data comes from the open enrollment period of November 2014 to January 2015. In the time period covered by this dataset the penalty for going uninsured had not been fully implemented. In 2014 the penalty for going uninsured was \$95 person or 1% of income whichever was larger. By 2016, when the penalty is fully implemented, the fine is \$695 or 2.5% of income. Problematically, according to a Gallup poll from 2013, 43% of the uninsured were not aware that they would face a penalty in the upcoming year.[24] The model does not have any means of accounting for household's awareness of the penalty, so a perfect comparison between the model and data is not possible.

Inputting the 2014's penalty into the model generates the distribution of insurance coverage shown in Table (1.5). Table (1.5) also reports the early enrollment data from HHS. Comparing the model's results to the cumulative 2015 HHS enrollment

[23] Early enrollment data from the Dept. of Health and Human Services, `http://aspe.hhs.gov/sites/default/files/pdf/83656/ib_2015mar_enrollment.pdf`

[24] Gallup Surveys, `http://www.gallup.com/poll/163280/uninsured-unaware-coverage.aspx`

data, reveals a close match. In the HHS data, the Bronze/Silver split predicted by the model, 24%/65%, closely matches the split in the data, 21%/70%. Furthermore, the predicted uninsured rate is a close match. The higher rate in the data can be partially explained by the lack of awareness regarding the penalty because removing the penalty completely results in an uninsured rate of 16.0%, higher than the data.

Table 1.5: Shares of Coverage Levels, With Partial Penalty for Going Uninsured

	Uninsured	Individual	Bronze	Silver	Gold	Platinum
Model	11.5	12.4	24.4	64.6	1.1	9.9
HHS Data	13.2	-	21	70	6	2

In the HHS data, 8% of enrollees selected a Gold or Platinum level plan. The model predicts that about 11% of the individual market purchases one of these higher coverage plans. The model does not match the Gold/Platinum shares exactly because Platinum plans are not available in many markets. Insurance companies offering plans on state-run health insurance exchanges are only required to offer Bronze, Silver, and Gold plans. Only, insurers offering plans on the federal exchange must sell all coverage levels.

1.5.2 Baseline Post-ACA Insurance Market

In this section I analyze the post-ACA model with all regulations stipulated by the law. The implementation of the ACA portends significant changes to the distribution of insurance coverage. Table (1.6) presents the changes to the shares of different types of insurance coverage before and after the reform for different education groups. The ACA causes a sharp drop in the uninsured share of the population, falling from 23.1% to 5.6%. The expansion of public insurance causes the share of the population with Medicaid to increase to 14.2%, leaving the bulk of the formerly uninsured in the community-rated individual market, which captures 18.4% of the working age population. Participation in the ESHI group market is relatively unchanged.

The lowest education cohort drives the overall change in the uninsured rate. The individual market becomes the most popular choice of households with less than a high school education, instead of going uninsured. The subsidies for premium assistance are inducing lower income groups to become insured. The elevated incomes of highly educated households preclude their eligibility for public insurance or subsidies, and thus the penalty induces them to participate in the individual and ESHI group market.

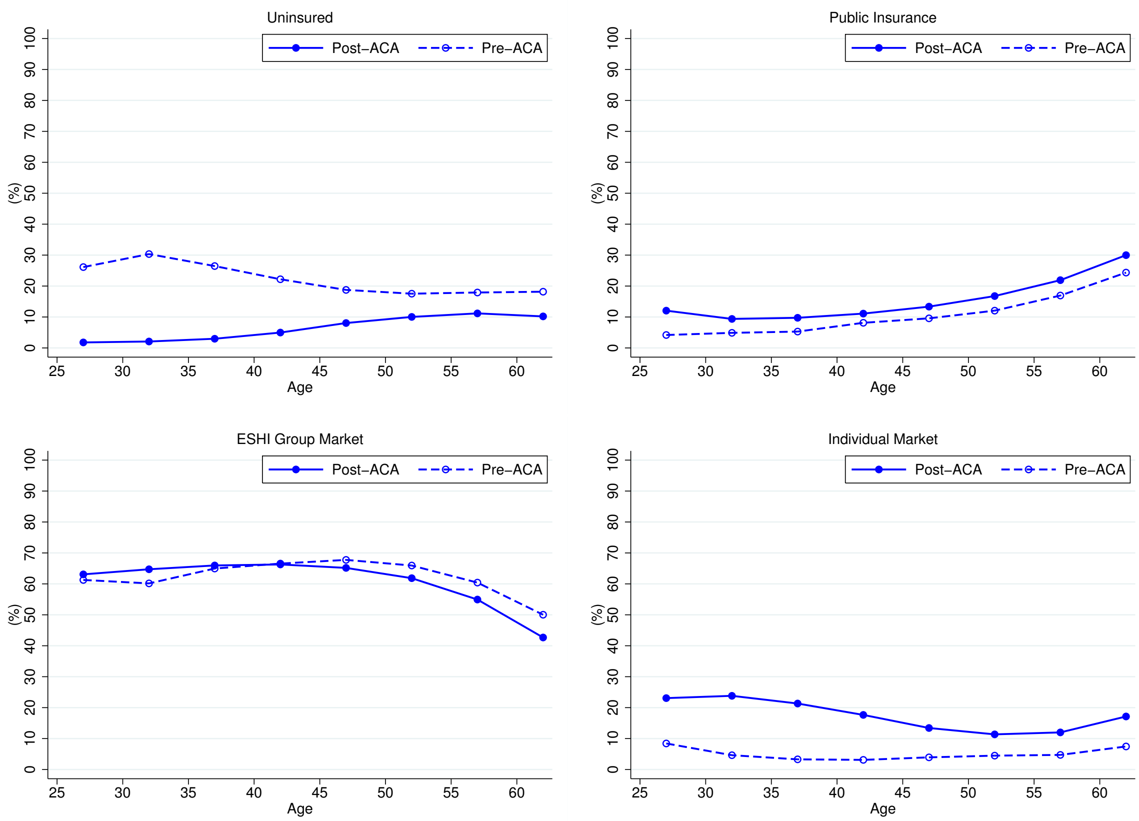
Table 1.6: Aggregate Statistics Pre-ACA and Post-ACA Models

	Total		**Less than HS**		**High School**		**College & Up**	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Uninsured	23.1	5.6	45.1	10.5	19.2	4.8	18.2	4.4
Medicaid	9.3	14.2	23.7	32.3	9.4	15.3	1.4	2.8
Individual	5.0	18.4	6.9	34.8	5.3	16.5	3.6	12.8
Group	62.6	61.8	24.2	22.4	66.1	63.4	76.8	80.0

Figure (1.6) presents the changes to the shares of different types of insurance by age before and after the reform. In the top-left panel we can see that the pre-ACA uninsured cohort is comprised mostly of younger individuals. Because their youth implies low medical expenses and their low income implies a higher utility loss from the consumption forgone to pay the insurance premium, they find it optimal to go uninsured. As a result of the penalty and subsidy, younger households not eligible for Medicaid pile into the community-rated individual market, the bottom-right panel. The increase in the individual market's share is substantially larger than the growth in Medicaid participation across all ages. The uninsured rate rises for older households because of the structure of the penalty. Households are exempt from the penalty if the Bronze premium exceeds 8% of their income. As premiums rise with age, more households become exempt from the penalty and go uninsured.

As shown in the bottom left panel, participation in the ESHI group begins to fall as households near retirement. As explained in more detail in a later discussion of the labor market changes, pre-ACA premium prices for individuals near retirement age are high because medical expenses begin increasingly rapidly after age 45. Older individuals find it optimal to remain working in order to purchase insurance through the ESHI group, because group insurance shares the high medical expenditure risk of older workers across less risky, younger workers. Post-ACA, eligibility for the subsidy is only dependent upon income. Older individuals with high medical expenditure risk, even those with high wealth, can retire early, lower their income, qualify for the subsidy, and get insurance through the individual market. Simultaneously, the penalty is pushing younger workers to accept their ESHI group offers. As a result, the premium in the group market falls from 5.9% to 5.3% of pre-ACA average household income.

Figure 1.6: Working-Age Insurance Shares by Age, Pre-ACA and Post-ACA Models



Taking a closer look within the community-rated individual market, Table (1.7) presents the relative shares of the different coverage levels for each educational group. Backing up the earlier claim that the subsidy is the driving force behind the insurance decision of less educated households, the distribution of coverage levels for households with less than a high school education is relatively more concentrated at the Silver level. 59.3% of consumers with less than a high school education, who purchase insurance through the individual market, select a Silver plan, compared to the second most popular choice of Bronze with 24.7%. In contrast, the distribution of coverage levels for households with a college education is skewed towards the Bronze plan. Lacking a subsidy, Bronze becomes the most popular choice of the college educated, with 52.2%, and the share selecting Silver is only 25.5%. But with greater incomes, the college educated are also motivated to select the Platinum plan at a higher rate than either of the lower education groups. Despite this, the key result is that more educated and higher income households on average get less coverage than lower income households.

Table 1.7: Aggregate Individual Market Insurance Share by Plan Level and Education

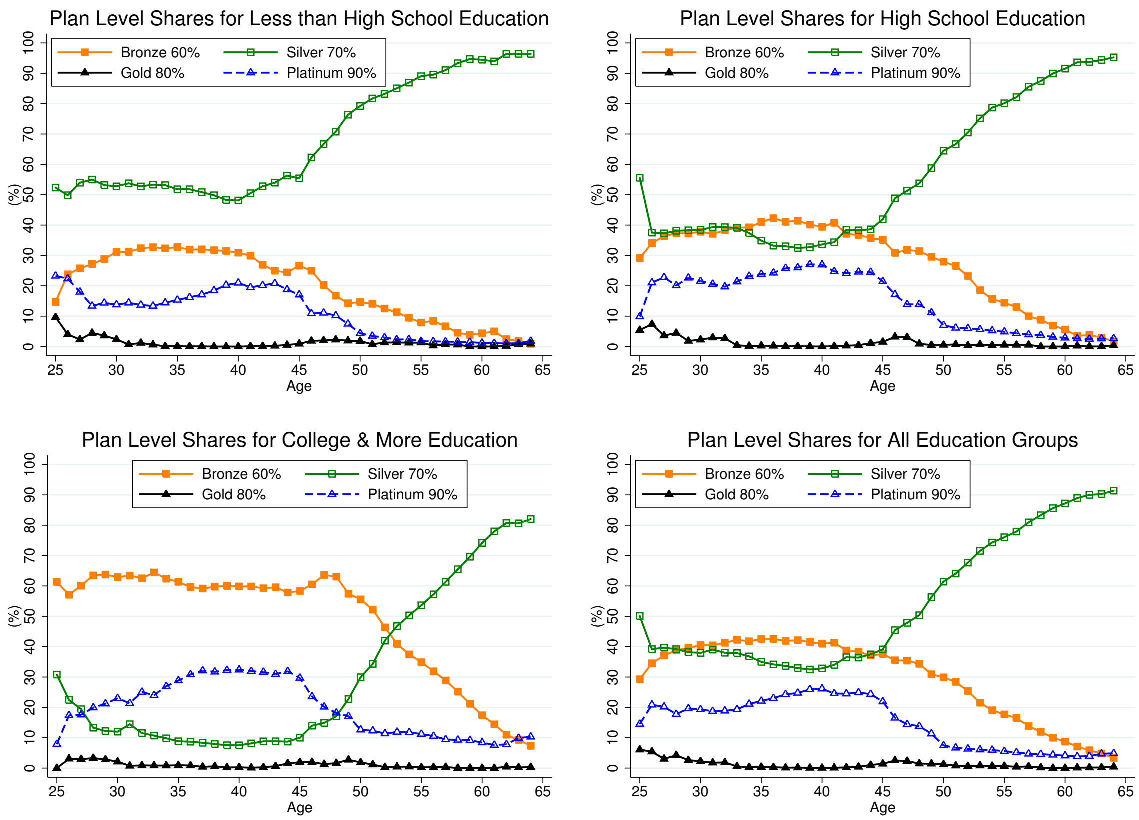
Education	Bronze (60%)	Silver (70%)	Gold (80%)	Platinum (90%)
Less than High School	24.7	59.3	1.7	14.3
High School or GED	31.9	48.5	1.6	18.0
College or more	52.2	25.5	1.1	21.2
Total	34.0	46.9	1.5	17.5

The distribution of chosen coverage levels is not smooth. Motivated to purchase insurance because of the penalty, the least medically risky select Bronze. Eligible for the subsidy, lower income households favor Silver. Demanding as much insurance as possible, households with high medical expenditure risk choose Platinum. Consequently, the Gold level attracts a scant 1.5% share of the individual market. But as mentioned perviously, Platinum plans are not offered in certain markets.

Dissecting the community-rated individual market even further, Figure (1.7) presents the relative shares of the different coverage levels for each educational group by age. Focusing first on households with less than a high school education, the most prominent feature that emerges is the strong preference for Silver level plans across all ages. One of the primary causes of the high pre-ACA uninsured rate is that underwriting results in those with low income being unable to afford their premiums. Post-ACA, this low-income group is still income constrained so they buy a subsidized Silver plan. Only at younger ages, when the size of medical expenses is smaller, and thus premiums are lower, does the lowest education and income cohort purchase Bronze or Platinum.

For households with a high school education, the shares of Silver and Bronze are relatively even at younger ages, roughly 40% and 35% respectively. Even Platinum garners a 20% share. But after age 45, the shares of Bronze and Platinum drop off as

Figure 1.7: Plan Level Shares by Education and Age



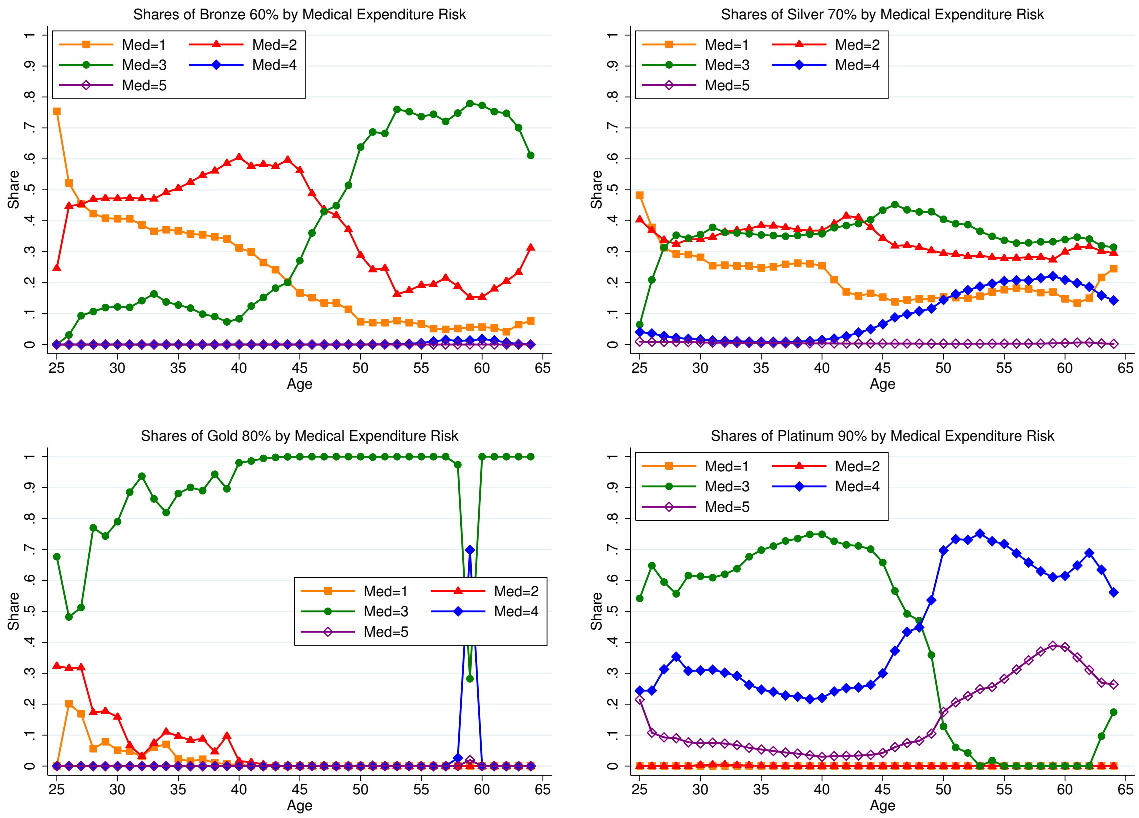
the share of Silver rises. Generally ineligible for the subsidy, college educated households prefer the Bronze plan over all others up to age 50. Distinct from the other educational groups, the highest coverage Platinum plan is the second most popular choice from ages 30 to 45 for college-educated households. Only with the onset of early retirement at age 45 does the share of the Silver plan begin to take off. As education rises so does income, higher educated households are less sensitive to the price increases across plans and are thus more inclined to purchase higher coverage. Higher income households also have more wealth, which puts them farther from the government's consumption floor and leaves their consumption more exposed to large medical expenditure shocks compared to low wealth households.

For households of all education levels, the mid 40's are turning point for the distribution of insurance choice. As seen in the MEPS data shown in the appendix, this time period marks the beginning of the escalation in medical expenditures. Because the fixed cost to leisure from working is higher for medically riskier individuals, these households want to retire earlier than their lower risk counterparts. Also, as mentioned before, when higher risk households retire early, they lower their income, becoming eligible for the subsidy. Eligibility for the subsidy induces the purchase of the Silver level. In addition, the introduction of riskier types into the individual market at older ages raises premiums, exacerbating adverse selection. Some less risky households, who favor the Bronze plan, go uninsured and premiums rise further. As a result, the markets for Gold and Platinum partially unwind as premiums become unaffordable for all but the highest income households. As premiums move higher more households become eligible for the subsidy. By age 64, the last working year, Silver commands over a 90% share of the individual market, the bottom right panel.

Taking a closer look at the distribution of medical expenditure risk at each coverage level, Figure (1.8) decomposes each plan in the individual market by the shares of each medical expenditure risk category. Recall from the calibration section that medical expenditure risk is divided into five groups corresponding to the (0-30th), (30th-60th), (60th-90th), (90th-99th), and (99th-100th) percentiles of previous year medical spending, which are named Med=1, Med=2, Med=3, Med=4, and Med=5, respectively. In the top-left panel we can see that healthy individuals with low medical expenditure risk, Med=1 and Med=2, dominate the Bronze plan at younger ages. For low risk types who were previously uninsured, income considerations dominate medical expenditure risk considerations. Post-ACA, the penalty induces the purchase of coverage, but since the benefit of consumption outweighs the mitigation of medical expenditure risk for this group, the lowest risk types buy the plan with the lowest premium, Bronze.

Because of the subsidy, income, and not medical expenditure risk, is the deciding factor in selecting a Silver plan. For this reason, the Silver level has the most heterogeneous mix of risk types. As shown in the top-right panel, healthier households, Med=1, Med=2, and Med=3, are almost evenly represented before age 40. At ages closer to retirement we see the inclusion of some riskier types, Med=4. For these individuals, the utility of extra consumption from a lower premium outweighs the extra risk sharing of higher coverage.

Figure 1.8: Plan Level Shares by Education and Age

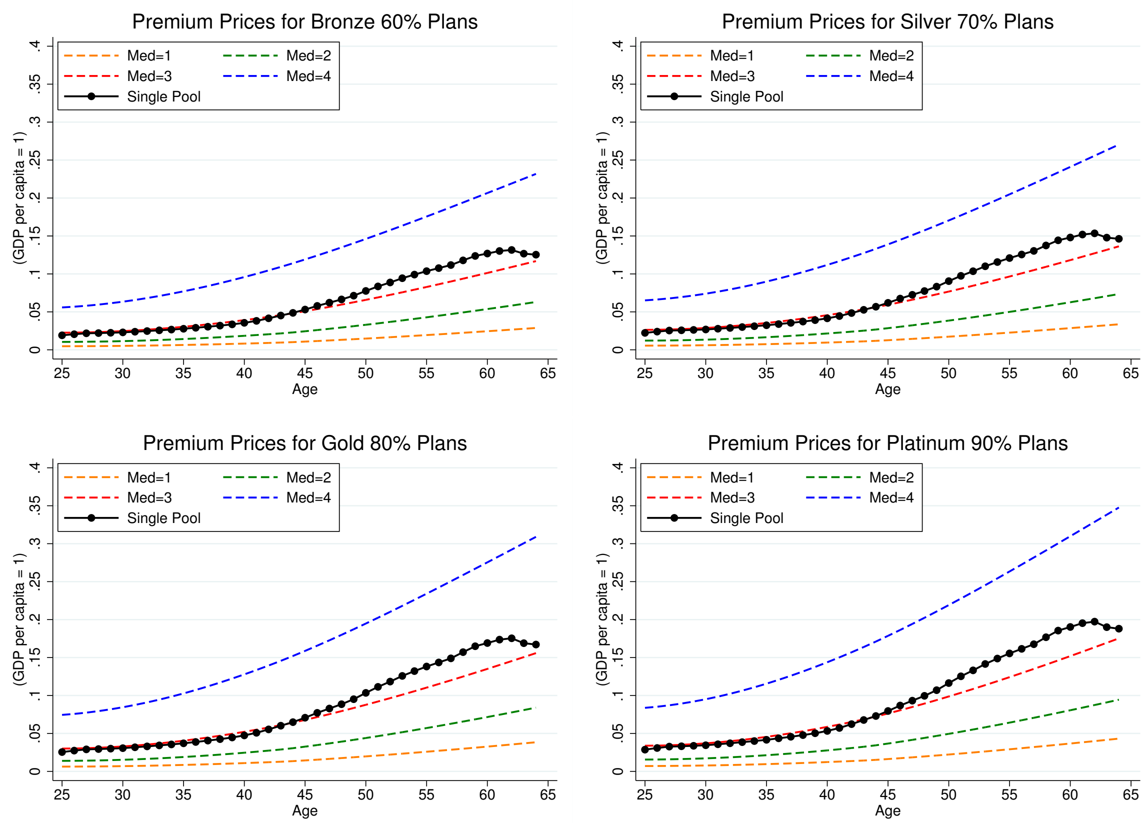


As seen in the bottom right panel, all of the riskiest type, Med=5, who participate individual market select the highest coverage Platinum plan. None of the least risky households, Med=1 and Med=2, select Platinum. While enrollees in the Platinum plan are significantly riskier than consumers in lower coverage plans, because signaling is prevented by the single risk pool insurers cannot condition the premium on this fact.

Because participation in the Gold level is relatively low, little can be inferred from the shares of different risk types selecting this level. No clear patterns emerge except that after age 40, the plan level is almost exclusively chosen by households with higher than average medical risk, Med=3. Before age 40 a few lower risk types, Med=1 and Med=2, select Gold.

Figure (1.9) shows the post-ACA premium prices in the individual market compared to the pre-ACA premium prices for a policy with the same coverage rate. In the post-ACA setting there is a single price at each age and plan level because of age-adjusted community rating. In the pre-ACA setting there are five possible prices for each age and plan level because underwriting conditions the premium price on medical history. The figure omits the pre-ACA prices for the Med=5 group because they are significantly higher than the rest, making it difficult to show them all in the same figure. In order to properly compare the pre- and post-ACA premiums, the fixed cost of underwriting is removed from the pre-ACA premium and the markup factor is lowered from 25% to 12%.

Figure 1.9: Premium Prices in the Pre-ACA and Post-ACA Individual Market



Up to age 50, the post-ACA premiums for all coverage levels are about equal to the pre-ACA premiums for a household with medical expenditure risk of Med=3, i.e. the 60th to 90th percentile. The same pattern emerges across all plans because, with the single risk pool, the insurer must hold the same expectation of medical expenses across all enrollees. Households participating in the post-ACA individual market are of higher than average risk compared to the overall working-age population. This result is consistent with the pre-ACA finding that many households go uninsured because underwriting reveals their high medical risk, making their premiums unaffordable. With the ACA, this higher risk group is more likely to participate in the individual market compared to low risk types.

Past age 50, premiums move higher as riskier types join the individual market from the ESHI group market. The jump in the premium at this age reflects the earlier discussion that the households with high medical expenditure risk tend to retire earlier. As this cohort of risky types leaves the ESHI group pool and joins the individual market, premiums rise.

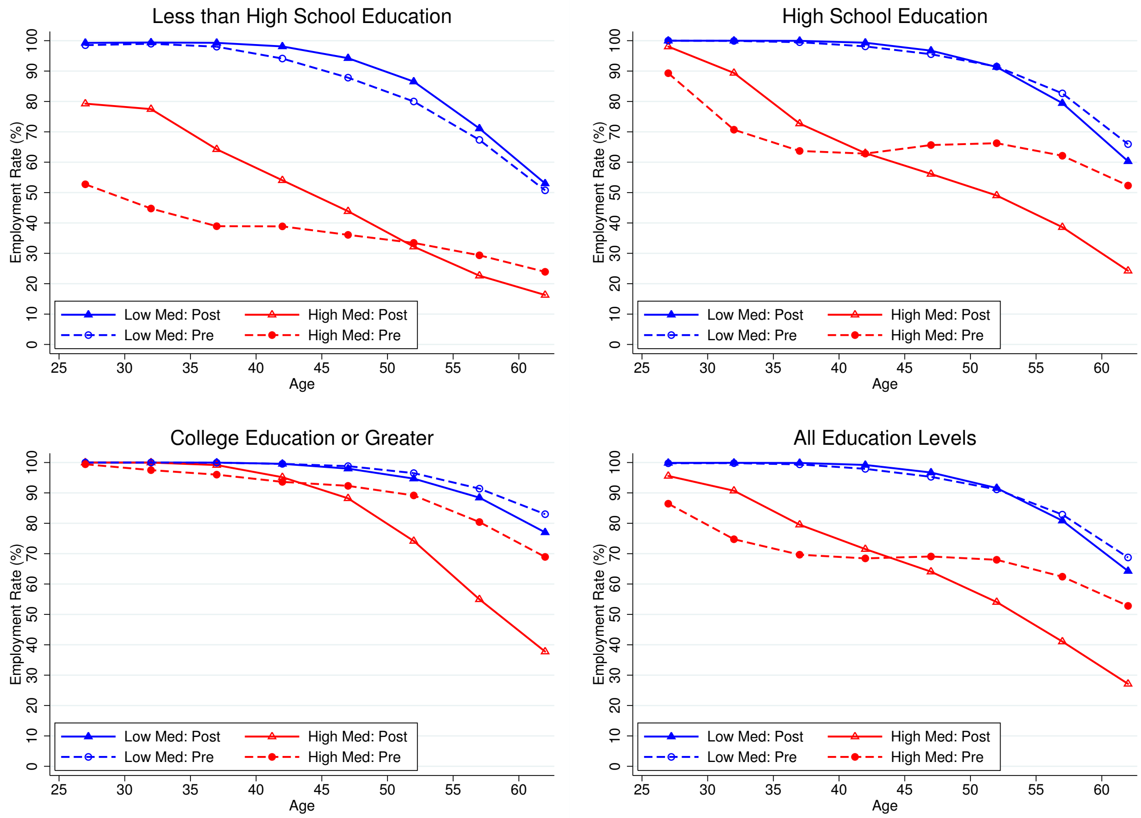
1.5.3 General Equilibrium Effects of ACA

Employment and Prices

The reform also portends changes to the labor market. Figure (1.10) compares the pre-ACA and post-ACA employment rates by age and education level. As opposed to Pashchenko and Porapakkarm (2012) and the February 2014 CBO Budget outlook who predict an employment decline following the ACA, my model predicts no change in employment.[25] Employment stays at 91.6%, but the composition of the labor force changes significantly. My results are also consistent with the findings of Nakajima and Tüzeman (2014) who find a small decline in hours worked from the ACA. In the top-left panel, we can see that the employment rate of the least educated individuals increases across both health categories and nearly all ages. Pre-ACA, many households in the low educated group choose not to work in order to retain Medicaid eligibility. With the expansion of public insurance and the provision of subsidies, younger and less educated households, especially those in high medical risk, work more. For households with a high school or college education who are low medical risk, the bottom-left and top-right panels, the employment rate remains

[25]Congressional Budget Office (CBO), February 2014 Budget Outlook, http://www.cbo.gov/sites/default/files/45010-Outlook2014_Feb_0.pdf

Figure 1.10: Employment Changes by Education, Age, and Medical Shock



relatively unchanged, decreasing slightly at older ages. Changes are more pronounced for households with high medical risk, who work more at younger ages but less after age 45. Pre-ACA, ineligible for public insurance, more educated households need to work in order to obtain insurance through the ESHI group. Post-ACA, the subsidies induce the highly educated to retire earlier, lower their income, obtain the subsidy, and insure through the community-rated individual market. The result that the creation of a new subsidized insurance option outside of the ESHI group increases the likelihood of retirement is consistent with the findings of Gruber and Madrian (1995), who find that workers at firms that offer continuation coverage retire earlier.[26] Earlier

[26]Continuation coverage is a program offered by some firms that allow recently separated workers to enroll in the firm's ESHI group pool for a specified period of time. An example of such practice is COBRA.

retirement occurs for all groups except the least educated with low medical risk.

In totality, since the outflow from the labor market largely consists of older, more educated workers while the inflow primarily comes from younger, less educated workers, the change in the composition of the labor force results in a decline in the average productivity of labor.

The firm finances its share of the ESHI group premium by making a deduction from the wage per effective unit of labor. Because the penalty encourages younger, less risky households to participate in the ESHI group while the subsidies discourage older, higher risk individuals from working, on average the ESHI group pool becomes less medically risky. In turn, the ESHI group premium falls while the total number of ESHI group enrollees falls too. As a result, the required deduction from the wage falls. Table (1.8) summarizes the changes to the firm's wage deduction for financing the ESHI group premium as well as the wage, interest rate, and measures of output, savings, employment, and the distribution of wealth.

Table 1.8: Pre-ACA and Post-ACA Comparison of Selected Aggregate Measures

Variable	**Pre-ACA**	**Post-ACA**
Output per Capita	1.00	0.98
Capital Stock	3.00	2.86
Interest Rate (%)	8.47	8.81
Gini Coefficient	0.530	0.528
Wage per Effective Unit of Labor (Pre-ACA GDP=1)	1.282	1.263
Employment Rate (%)	91.6	91.6
Firm's Wage Deduction for ESHI Premium (Pre-ACA GDP=1)	0.054	0.048

After the reform the capital stock falls 4.7%. In the pre-ACA setting, because underwriting excludes a large portion of the population from the insurance market, individuals without a group offer use the risk-free asset in order to smooth consumption in the face of the medical expenditure shocks. With more households becoming insured, this savings motive is reduced. Also, the earlier retirement of higher risk households lowers their incomes and reduces savings. The reform does little to change wealth inequality as the Gini coefficient inches lower in the post-ACA economy, suggesting the redistributive measures of the ACA only slightly reduce inequality.

The general equilibrium effects of the reform are limited. The interest rate on the risk free asset rises 0.34% while the wage per effective unit of labor falls 1.48%. These changes are consistent with the decline in the capital stock and lower average productivity of labor. In turn, these changes combine to shave 2% off aggregate output. As part of a partial equilibrium analysis, the wage, interest rate, and proportional income tax rate were fixed. Solving for the equilibrium premium prices in the partial framework did not significantly alter the allocation of households across insurance choices or employment.

Government Budget

The provision of the subsidies, expansion of Medicaid, and the changing composition of the labor force results in a increase in government medical spending and taxes, as shown in Table (1.9), which presents the changes to the major components of the government's budget. Recall from the previous discussion of the employment changes that as a result of the changing composition of the labor force the average level of productivity falls. Since the labor force has lower average productivity and the employment rate is almost unchanged, if income tax rates were held constant, revenue would be lower. Lower wages imply that the payroll taxes that help finance the Social Security and Medicare programs generate less revenue, worsening the fiscal positions for these programs. The effect on Social Security is more pronounced since its financing is more dependent on its payroll tax, relative to Medicare which also has premium support.

As shown in Table (1.9), the provision of the subsidies, combined with the ex-

Table 1.9: Change in Components of Government Budget Brought By Reform

	Change (%)
Proportional Income Tax Rate	+1.2
Government Medical Spending for Working Ages	+54.3
Government Social Assistance for Working Ages	-53.5
Government Social Assistance for Retired Ages	-8.3
Medicare Deficit	+1.1
Social Security Deficit	+6.8

pansion of Medicaid, results in 54.3% increase in government medical spending for working ages. This increase is offset by a drop in social assistance for working ages but only slightly given the relatively small size of the social assistance program compared to Medicaid. Lower revenues combined with increased spending necessitate an increase in the proportional income tax rate of 1.2% in order for the government to balance its budget. Despite the law's creation of a new income tax bracket for the highest income households, the number of individuals in this tax bracket is insufficient to generate the additional revenue needed to finance the new outlays. However, life-cycle models are notorious for their inability to generate a mass of households at extremely high wealth levels, as observed in the data. Thus the new tax bracket is likely affecting too few households in the model.

Welfare Changes

Given that the ACA has multiple redistributive, as well as regulatory, components, the sign and magnitude of the welfare changes vary substantially across the distribution of households. Table (1.10) shows the welfare changes by education, income, ESHI status, and medical expenditure risk as measured by consumption equivalent variation (CEV) of the 25-year-old "newborns".[27] A positive amount indicates the percent of pre-ACA consumption a household would give up during the first period of their life in order to be indifferent between living in the pre-ACA and post-ACA economies.

Overall the welfare change is positive with newborns willing to give 1.76% of their first year consumption to live in the post-ACA economy. Households endowed with less than a high school education realize the greatest gains from the reform, with an average CEV of 3.57%. However, this improvement comes at the expense of college educated households, who register a CEV of -1.51%. The source of this discrepancy becomes more apparent when viewing the CEVs across income groups. The CEVs decrease as income rises suggesting that the redistributive elements of the ACA, i.e. the subsidies, public insurance expansion, and more progressive income tax, are driving the welfare changes. The increase in taxation and forced provision of insurance

[27]CEV is calculated as $CEV(x) = 100\left[1 - \left(\frac{V^B(x)}{V^R(x)}\right)^{\frac{1}{\chi(1-\sigma)}}\right]$ where $V^B(x)$ is the pre-ACA ex ante value function of a new born (age 25) endowed with state (x) and, similarly, $V^R(x)$ is the post-ACA ex ante value function.

Table 1.10: Consumption Equivalence Variation of the Post-ACA Economy

Overall	**Less than HS (LE)**			**High School (HE)**		**College (XE)**	
1.76	3.57			0.80		-1.51	
	LE			**HE**		**XE**	
υ_j	$\zeta_j = 1$	$\zeta_j = 2$		$\zeta_j = 1$	$\zeta_j = 2$	$\zeta_j = 1$	$\zeta_j = 2$
1	4.58	4.59		3.10	2.99	0.03	1.38
2	4.59	5.00		2.88	3.62	1.54	0.37
3	4.50	5.03		3.51	2.18	0.56	-0.50
4	4.78	3.67		2.28	0.91	-1.34	-1.47
5	3.74	2.68		0.02	-0.32	-1.91	-1.95
6	2.04	1.65		-0.79	-0.93	-2.18	-2.18
7	1.58	0.99		-1.24	-1.26	-2.34	-2.35
8	0.86	0.55		-1.44	-1.39	-2.40	-2.38
9	0.56	0.62		-1.42	-1.30	-2.39	-2.31
	No ESHI Offer			**ESHI Offer**			
LE	3.70			2.85			
HE	1.42			2.85			
XE	-0.81			-1.63			
	Med=1	**Med=2**	**Med=3**	**Med=4**	**Med=5**		
LE	2.95	3.42	4.06	4.31	4.14		
HE	0.58	0.81	0.89	1.07	1.74		
XE	-1.50	-1.51	-1.55	-1.47	-1.15		
All	1.38	1.69	2.00	2.25	2.54		

Labor productivity is the log sum of a persistent AR(1) shock, υ_j, and a white noise shock, ζ_j. The persistent shock is calibrated with nine grid points and the transitory with two. Higher grid points correspond to larger shocks.

through the penalty explain the overall welfare loss of the college-educated. Public insurance is valuable to lower income households because it provides a generous coverage level with no premium. Relaxing the income constraint on public insurance eligibility diminishes the incentive the forgo employment to maintain eligibility. This result is consistent with Pashchenko and Porapakkarm (2012) and Nakajima and Tüzeman (2014), who find that the redistributive measures of the ACA deliver most of the welfare gain.

Households without an ESHI offer realize a greater welfare gain than households who do. Since the ACA is intended to provide insurance coverage to previously uninsured households, this result is sensible. But even households with a high school education or less who receive an ESHI offer realize a positive welfare gain. Whether a households starts their life with an ESHI offer or not, given the uncertainty about whether an ESHI offer will be received in future periods, a risk averse households prefers the age-adjusted community rated insurance market of the post-ACA economy to the underwritten insurance policies in pre-ACA economy. This preference is reinforced by the correlation of high medical expenses with periods of unemployment, i.e. no ESHI offer.

The welfare gains are increasing in medical expenditure risk across all education cohorts. As mentioned before, many pre-ACA households are uninsured because their high medical expenditure risk results in an unaffordable premium. By forming a single risk pool and providing subsidies, the riskiest households are able to obtain inexpensive, high coverage level and share their risk. The welfare gains of the lower education groups are larger than the college-educated because the college-educated are more likely to access coverage through the ESHI group market. While the ESHI premium falls, the rise in taxation and induced purchase of insurance by the penalty result in a consumption loss that outweighs the benefits of the reform.

1.5.4 Single versus Separate Risk Pools

In this section, I analyze the premium pricing regulation. I maintain the requirement that insurers uniformly price plans for each age group. However, instead of requiring insurers to form a single risk pool across all plans for each age, I allow insurers to form separate risk pools according to enrollees' chosen coverage level. In this way, insurers can use the information contained in the signal of a household's desired coverage level to inform their beliefs regarding the medical expenditure risk of the enrollee. I refer to the former arrangement as the 'single pool' and the latter arrangement as 'separate pools'. 'Single pool' can also be thought of as the 'no signaling' scenario and the 'separate pools' can be thought of as the 'with signaling' scenario. In both the 'single pool' and 'separate pools' scenarios households have four coverage level choices, each representing one of the four Metal tiers, $q_j \in \{60\%, 70\%, 80\%, 90\%\} = \{Bronze, Silver, Gold, Platinum\}$. For each scenario I include all other components of the reform, including the subsidy, penalty, and public insurance expansion.[28]

[28]Extensive testing reveals that adding and removing the other components of the reform, i.e. the subsidy, penalty, and public insurance expansion, does not alter the relative ranking of welfare

The most noteworthy finding of this section is that while 'separate pools' produces the lowest uninsured rate, 'single pool' generates a larger welfare gain. With a 'single pool', households with higher medical expenditure risk, who also value insurance more, obtain higher coverage plans. Also, households with a high school or college degree benefit more than households with less than a high school degree from the imposition of a single risk pool.

Table (1.11) shows the post-ACA aggregate level and distribution of insurance coverage for working age households for the 'single pool' and 'separate pools' scenarios. Public insurance and ESHI are excluded from the table because they do no vary significantly across the two scenarios. With 'separate pools' the fewest number of households go uninsured. The lower uninsured rate is the result of healthier individuals being more likely to insure because they can signal their low risk by choosing the lowest coverage, Bronze, plan, pay a low premium, and forgo the penalty for being uninsured. However, selecting a Gold or Platinum plan signals high medical expenditure risk and the corresponding increase in premiums sets off an adverse selection spiral, which completely unwinds the market for the highest coverage plans. Adverse selection is halted at the Silver level because the design of the subsidy, that premiums not exceed a portion of household income, insulates poor enrollees from the full premium. Pre-ACA, many households go uninsured because they cannot afford their insurance or their medical expenditure risk is very low. Post-ACA, with separate risk pools households with previously unaffordable premiums pool in the subsidized Silver plan and low risk households pool in the lower, Bronze plan.

Table 1.11: Distribution of Insurance Coverage With and Without Signaling (Mkt. Share %)

	Uninsured	Individual Market		Bronze	Silver	Gold	Platinum
Pre-ACA (Model)	23.1	5.0		-	-	-	-
Single Pool	5.6	18.4		34.0	46.9	1.5	17.5
Separate Pools	3.7	19.9		58.8	41.2	0.0	0.0

Imposing the 'single pool' motivates households with the highest medical expendi-

changes for the 'separate pools' and 'single pool' scenarios. However, removing the subsidy and the penalty results in an identical welfare gain for both since adverse selection unwinds the entire individual market and only the riskiest participate in the exchanges.

ture risk to switch to higher coverage plans, increasing premiums, and inducing some low risk households to go uninsured. With 'single pool', the uninsured rate goes to 5.6%, compared to 3.7% under 'separate pools'. With 'single pool', of the portion of the working age population that participates in the individual market, 17.5% get the highest coverage Platinum plan while 34.0% choose the lowest coverage Bronze plan. Because of the subsidy, Silver is the most popular choice with 46.9% of the individual market.

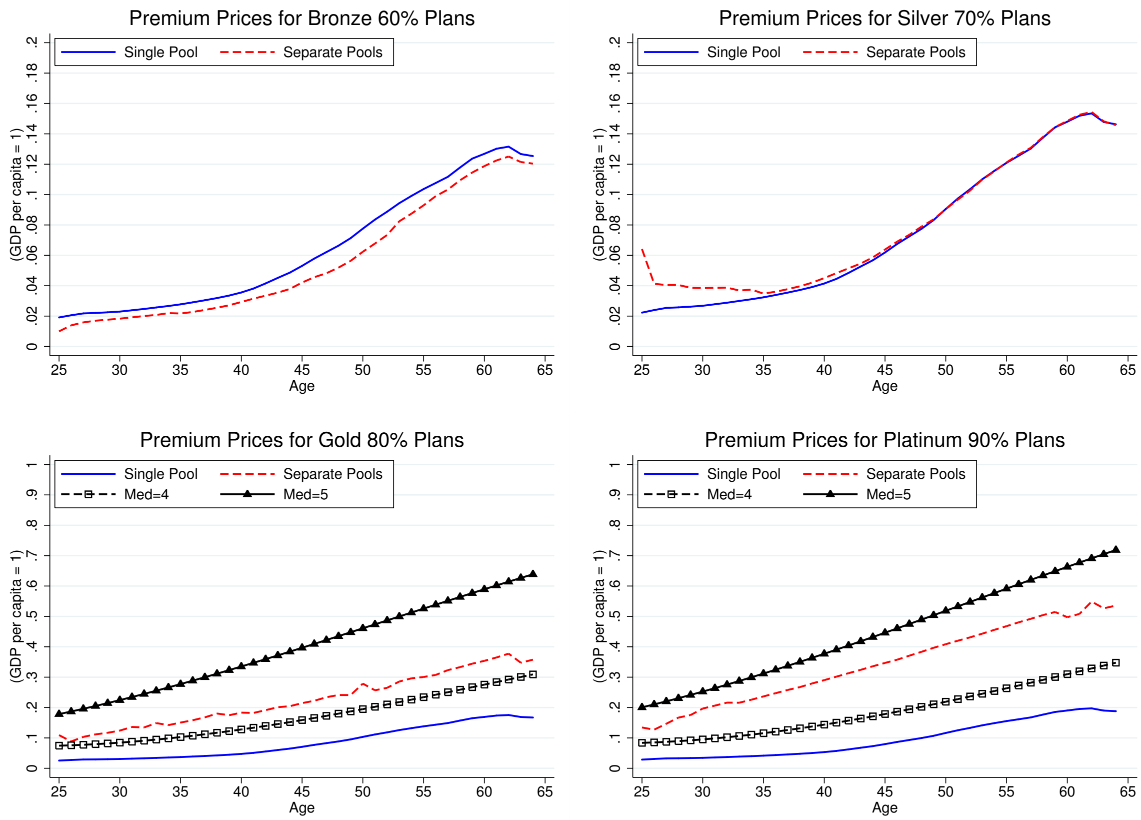
Figure (1.11) shows the premium prices for the 'single pool' and 'separate pools'. For comparison, the premiums for Gold and Platinum, i.e the bottom two panels, also include two additional series showing what the premiums for these plans would have been if they were exclusively purchased by the highest risk types, Med=4 or Med=5.

The top left panel shows that with 'separate pools' the Bronze plan is cheaper than with 'single pool'. With 'separate pools' lower risk households can signal their healthy state by choosing the lowest coverage plans and avoid pooling with higher risk types who prefer more coverage. Because the Bronze plan is cheaper fewer households go uninsured with 'separate pools' than with 'single pool'. The premium for the Silver plan, top right panel, is virtually identical across the two scenarios. Because the subsidy is only applied to Silver plans, income, not medical risk, is the primary motivation for selecting Silver.

As discussed in the appendix, multiplicity of equilibria is a well-known issue in signaling models of asymmetric information because the definition of Perfect Bayesian Equilibrium does not discipline the off-equilibrium path beliefs of insurers. In the 'separate pools' scenario no households buy Gold or Platinum plans. Therefore, some analysis of the off-equilibrium path premiums generated by my computational algorithm is warranted in order to ensure that the beliefs are 'reasonable' according to the flavor of the Intuitive Criterion.

Recall, for the initial guess of the premiums I assume insurers have the most optimistic beliefs regarding enrollee's risk, i.e. all enrollees are of the lowest risk type. With each iteration of the computational algorithm the premiums slowly rise and adverse selection induces consumers to switch to lower coverage plans. Once all households move out a plan the premium is left unchanged in all successive iterations. As shown in the bottom two panels, with 'separate pools' the off-equilibrium path

Figure 1.11: Employment Changes by Education, Age, and Medical Shock



premiums for Gold and Platinum plans are between the hypothetical premiums that would break even if the Gold and Platinum markets were comprised exclusively of either the two highest risk types.[29] Because the equilibrium premiums are above the Med=4 premium, the last consumer to leave the Gold or Platinum market must have been of type Med=5. Therefore, if an insurer tried to offer a lower premium it would induce a deviation by the highest risk, Med=5, type. But then the new insurer would have to exit the market because the premium did not break even. Thus, the nature

[29] Any higher premium for Gold or Platinum would also deliver the same equilibrium. The off-equilibrium Gold premium is close to the premium of Med=4 because as enrollees switch out of the Platinum plan they prefer Silver because of low premium, as opposed to the higher coverage and cost of Gold. By choosing Silver or Bronze they high risk household can pool with lower risk households and 'hide' their type.

of the off equilibrium path beliefs induced by my computational algorithm seem reasonable.

Table (1.12) shows the welfare changes, pre-ACA versus post-ACA for each scenario by educational group. Removing signaling, and thus information, through the single risk pool delivers a larger welfare gain than separate risk pools. Consistent with Hirschleifer (1971), more information is damaging to welfare, even across all educational groups. In the previous literature on choice and adverse selection, Cutler and Reber (1998), Cutler and Zeckhauser (1998), Bundorf, Levin, and Mahoney (2008), Einav, Finkelstein, and Cullen (2008), and Carlin and Town (2009), choice lowers overall welfare. But as my research demonstrates, the caveat is that having a choice over coverage level harms welfare when that choice acts as an informative signal of risk. This signaling can be prevented by forming a single risk pool, as the ACA does. While the single risk pool allows riskier households to obtain higher coverage, which raises premiums, worsens adverse selection, and increases the uninsured rate, the welfare gain from more risk sharing outweighs the loss from more uninsured. Preserving choice increases welfare by allowing consumers to select the plan that is more individually optimal, given their income and risk.[30]

Removing signaling with a single risk pool shares the benefit of the subsidy with households with high medical risk, regardless of income. When health changes and medical expenditure risk increases individuals want to switch to higher coverage plans. With a single pool, premiums cannot be conditioned on desired coverage level so the increase in costs at the higher coverage plan is partially shared across all lower plan levels. Yet households with subsidies for Silver plans do not realize this price increase because their share of the premium is capped. The increase in subsidies is balanced out by an increase in the income tax rate.

Table 1.12: Welfare Changes of Newborns by Education, (CEV, %)

	All	Less than High School	High School	College & Up
Single Pool	1.76	3.57	0.80	-1.51
Separate Pools	1.43	3.31	0.43	-1.92

[30] A counterfactual with only one coverage level choice was performed and the welfare changes are nearly the same as the separate risk pooling scenario.

The source of the welfare gains from removing signaling and preserving choice through the single risk pool becomes more apparent upon inspection of the welfare changes by medical expenditure risk category, as shown in Table (1.13). Households with the highest medical expenditure risk (Med=5) realize the largest improvement to welfare from the single risk pool compared to separate pools, but even the welfare of low risk households rises significantly. At the beginning of their lives households know with some probability that their health could deteriorate and their medical expenditure risk could rise. Since medical expenditure risk and income are correlated, a medical event is likely to coincide with being ineligible for ESHI. In this situation, households will only be able to purchase the highest coverage Platinum plan if signaling is absent and choice is preserved. Removing signaling lowers premium reclassification risk, i.e. the change in a premium caused by a change in risk. Despite having to pay higher premiums on the lower coverage plans, even the least medically risky households prefer no signaling because they are risk averse and fear the utility loss of large medical expenditure shocks in their future.

Table 1.13: Welfare of Newborns by Medical Expenditure Risk, (CEV, %)

	Med=1	Med=2	Med=3	Med=4	Med=5
Single Pool	1.38	1.69	2.00	2.24	2.54
Separate Pools	1.10	1.39	1.65	1.79	1.85

Recall from the calibration, households with state Med=1 have the lowest medical expenditure risk, and Med=5 have the highest.

1.6 Counterfactuals

Since the ACA's passage the law has come under scrutiny by the U.S. Supreme Court, while the U.S. Senate and Congress have proposed several amendments to the legislation.[31,32] Furthermore, as of July 2015, 19 states have decided not to adopt the Medicaid expansion. Given the potential for future changes to the law, the purpose of this section is to determine how each component of the ACA, i.e. the subsidies, penalties, and Medicaid expansion, contributes to the law's changes to insurance coverage, employment, taxes, and welfare. Table (1.14) provides a description of the components that were adjusted for each counterfactual. In each counterfactual I assume a single risk pool. The "Post-ACA" counterfactual is the baseline case with all regulations included. "Post-ACA" is the baseline, 'single pool' case detailed in section (1.5).

Table 1.14: Names and Descriptions of the Counterfactuals

Name	**Description**		
Pre-ACA	The economy before the passage of the ACA		
	Subsidy	**Penalty**	**Medicaid Expansion**
Post-ACA	Yes, for Silver	Yes, \$695	Yes, 133% of FPL
No MCD Expand	Yes, for Silver	Yes, \$695	No
No Penalty	Yes, for Silver	No	Yes, 133% of FPL
No Subsidy	No	Yes, \$695	Yes, 133% of FPL

The principal result of this analysis is that the penalty lowers the uninsured rate more than any other regulation but reduces the welfare gains from the reform. The subsidy and public insurance expansion are critical to the overall welfare gain, but their provision has important consequences for labor markets, namely early retire-

[31] "Supreme Court Upholds Health Care Law, 5-4, in Victory for Obama", http://www.nytimes.com/2012/06/29/us/supreme-court-lets-health-law-largely-stand.html?_r=0, "Supreme Court Allows Nationwide Health Care Subsidies", http://www.nytimes.com/2015/06/26/us/obamacare-supreme-court.html

[32] "G.O.P. Lawmakers Propose Alternative to Obamacare", http://www.nytimes.com/2015/02/05/us/politics/gop-lawmakers-propose-alternative-to-obamacare.html

ment. The levels and distribution of insurance choices vary considerably depending on which components of the ACA are excluded. Without the subsidy, the distribution of coverage is bimodal, concentrating at the highest and lowest coverage levels.

1.6.1 Insurance Changes

Table (1.15) presents the distribution of insurance coverage for the counterfactuals. Removing the public insurance expansion, the "No MCD Expand" counterfactual, results in a similar uninsured rate to the baseline "Post-ACA" counterfactual, 5.8% versus 5.6%, but enrollment in public insurance and the individual market changes markedly. Only 6.1% of working-age households choose Medicaid, instead of 14.2%, and the individual market swells from 18.4% to 23.9%. The households that would have qualified for Medicaid under the expansion are instead eligible for the most generous level of subsidies. Since these low-income households earn less than 133% of the FPL, their premiums cannot exceed 2% of their income. Instead of Medicaid, these households opt for Silver level plans, growing its share of the individual market from 46.9% to 58.0%. States that do not adopt the Medicaid expansion should experience higher individual market enrollment than states that do. On average, the states pay for 40% of Medicaid outlays while the federal government covers 60%. But the federal government pays for 100% of the subsidies, which may explain why some states have forgone the expansion.

Just removing the penalty for going uninsured, the "No Penalty" counterfactual, results in an uninsured rate of 16.0% compared to the Post-ACA baseline of 5.6%. The penalty produces the largest drop in uninsured compared to all the other regulations. Removing the penalty induces less risky households to go uninsured and premiums rise, exacerbating adverse selection and causing more to go uninsured. Because of the single risk pool less risky households are unable to use their choice of coverage level to signal their low medical expenditure risk so they must cost share with the riskiest households or go uninsured. Without the penalty only 9.9% of the working-age population participates in the individual market and the distribution of coverage is highly concentrated at the Silver level, 77.6% of the individual market. Without the participation of the less risky households premiums rise, encouraging

Table 1.15: Market Shares of Insurance Choices for Counterfactuals

Scenario	**Uninsured**	**Medicaid**	**ESHI**	**Individual Market**
Pre-ACA	23.1	9.3	62.6	5.0
Post-ACA	5.6	14.2	61.8	18.4
No MCD Expand	5.8	6.1	64.3	23.9
No Penalty	16.0	14.2	59.9	9.9
No Subsidy	11.4	16.3	62.4	9.9
	Individual Market (Shares, %)			
	Bronze	**Silver**	**Gold**	**Platinum**
Pre-ACA	-	-	-	-
Post-ACA	34.0	46.9	1.5	17.5
No MCD Expand	26.5	58.0	1.3	14.2
No Penalty	11.4	77.6	0.4	10.6
No Subsidy	63.5	5.1	5.3	26.1

further switching to the subsidized Silver plan. Without the penalty, eligibility for the subsidy becomes the deciding factor of whether to purchase individual insurance. The penalty is the primary reason that younger households, who were eligible for ESHI but refused the offer, now accept their ESHI offer. Without the penalty, ESHI's market share is the lowest of any of the scenarios considered.

Eliminating the subsidies, the "No Subsidy" counterfactual, produces an uninsured rate of 11.4%. So while the subsidy causes fewer households to go uninsured, the effect is not as large as the penalty. Absent the subsidy, the individual market is also smaller as more individuals obtain coverage through Medicaid. Fewer households participate in the individual market compared to all the other counterfactuals considered. Medicaid's share of working age adults reaches 16.3%, the largest of any of the counterfactual considered. Absent the subsidy, the popularity of Silver evaporates. Instead, households pool at the highest and lowest coverage levels. Bronze secures 63.5% of the individual market while Platinum takes 26.1%. The subsidy is the deciding factor of whether to purchase insurance for lower income households. Without it, they elect for the most inexpensive plan, Bronze, that allows them to avoid the penalty.

1.6.2 Employment, Tax, and Welfare Changes

Table (1.16) presents the changes to employment, taxes, and welfare for the counterfactuals. As discussed above, altering the components of the law drastically changes the distribution of insurance coverage. Employment does not vary significantly across the counterfactuals except for the "No Subsidy" case. Reinforcing the earlier result that the subsidy reduces employment by encouraging early retirement, removing the subsidy causes the employment rate to rise to 91.9% compared to 91.6% in the baseline Post-ACA. Households that previously went unemployed to obtain public insurance now work more, as employment rises slightly in the "No MCD Expand" scenario. The penalty is having a negative employment effect as the fine induces households to not work in order to lower income and avoid the penalty.

Table 1.16: Employment, Taxes, and Welfare Changes for Counterfactuals

Scenario	Employment (%)	Tax Rate (%)	Average CEV (%)
Pre-ACA	91.6	9.8	-
Post-ACA	91.6	11.0	1.76
No MCD Expand	91.7	10.3	1.06
No Penalty	91.5	11.0	2.24
No Subsidy	91.9	10.9	1.16

Analyzing the changes to the proportional income tax rate under the different counterfactuals reveals that the public insurance expansion is the primary motivator behind the increase in government spending, not the subsidy. Without the Medicaid expansion, the tax rate rises to only 10.3%, compared to 10.9-11.0% across the other counterfactuals. Pre-ACA the median threshold for Medicaid eligibility across states is 88% of the FPL. By increasing the threshold to 133% of the FPL, the ACA significantly increases the fraction of Medicaid recipients. Furthermore, recall that Medicaid has no premium support and provides a very high coverage level relative to private insurance. Thus, government spending increases more significantly compared to when the government provides a premium subsidy to purchase private insurance. The penalty does not generate significant revenue because so few households go uninsured, and thus penalty revenue does not offset the spending increase.

Each regulation has a distinctly different effect on the welfare gains of the reform.

Most notable of all the counterfactuals considered, removing the penalty increases welfare above the baseline case, delivering a CEV of 2.24% compared to 1.76% in the baseline, whereas altering any of the other components reduces the welfare gain. The source of this improvement comes from the deleterious effects of the penalty on less educated households with high productivity and low medical expenditure risk.

Less educated households with low medical expenditure risk, who start their lives with a high productivity draw, would prefer to go uninsured. Since these households expect that their productivity and income will revert to the mean of their education cohort in future periods, they would rather forgo paying the premium and save more now to smooth consumption. The penalty redistributes resources from low-risk households to high-risk households. Because low risk, high income households are already participating in the ESHI group market at high rates before the ACA, the penalty is primarily affecting low risk, less educated households. Removing the penalty raises the welfare of the less educated households.

By this same reasoning, removing the subsidy harms the welfare of higher risk households who want insurance, lowering the overall welfare gain to 1.16%. As opposed to the penalty, the subsidy redistributes resources from high to low incomes. Shutting down the subsidy, the utility loss of the low-income group outweighs the utility gain of the high-income group because of decreasing marginal utility. For the same reason, removing the Medicaid expansion proves harmful to welfare. Because low income is correlated with bad health, Medicaid primarily helps high-risk, low-income households.

1.7 Conclusion

The Patient Protection and Affordable Care Act introduces a series of new regulations to the health insurance market. To study how each of the law's regulation affects insurance choice, employment, taxes and welfare, I construct a life cycle model of consumer signaling in the health insurance market and incorporate exogenous medical expenditure risk, idiosyncratic productivity risk, and a detailed description of the insurance industry. The model shows that allowing coverage level to signal information about medical expenditure risk erodes participation in the highest coverage plans. Consistent with the Hirshleifer effect, more information is damaging to welfare. The penalty reduces the number of uninsured but harms welfare. The subsidy motivates households to insure more and select the Silver plan, but also encourages early retirement. The public insurance expansion is the primary driver of the tax increase.

Beyond the results, this research also successfully demonstrates a methodology for computing general equilibria while expanding the choice set of insurance coverage. Whereas previous research has been limited to one or two insurance options, the number of choices in my model more accurately reflects the multiple plans available on the ACA exchanges. While I demonstrate a methodology for expanding the insurance choice set, this method still does not capture insurers ability to design their plans in an effort to screen for certain household types. Further work is need to expand the contract space along other dimensions, such as deductibles.

Also, further work is needed to include several omitted components of the ACA. In addition to risk pooling across plan levels, the ACA also risk adjusts across ages by mandating that the premium of a 65 year old not exceed three times the premium of a 25 year old for the same coverage level. This adjustment is likely to increase adverse selection as a portion of the premiums for the young and less risky are used to support the higher costs of the older and riskier enrollees. Because of the simple description given to the structure of firms in the model, this research does not explore the effects of the employer mandate, which requires that firms with 50 or more workers offer ESHI group insurance or pay a tax. This research also does not address the moral hazard of insurance coverage created by the endogeneity of medical expenditures. Nor does the model recognize that insurance coverage is often a joint decision made by spouses or on the behalf of dependents. All of these simplifications present avenues for future research.

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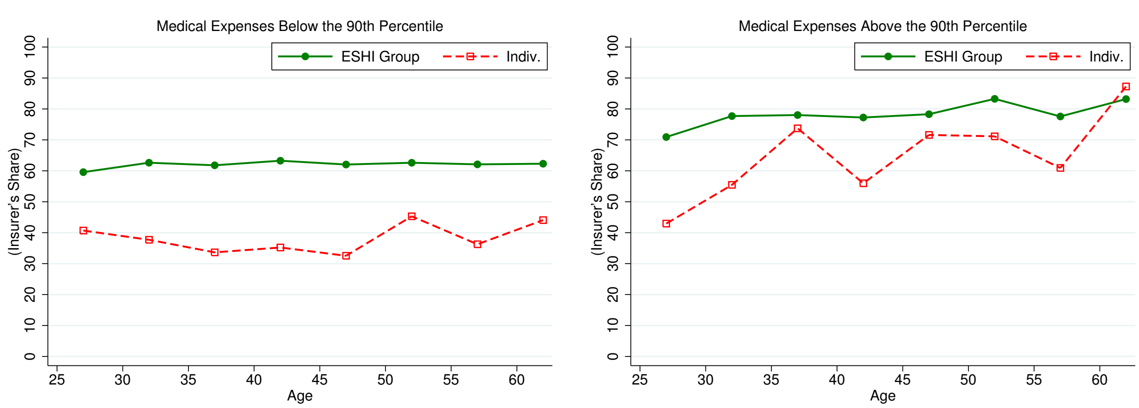
A Appendix

A.1 Idiosyncrasies of the Pre-ACA Individual Market

My research coincides with a growing body of macro-health literature studying health insurance industry reform in a dynamic general equilibrium setting, including Pashchenko and Porapakkarm (2012), Janicki (2011), Jung and Tran (2010), Hansen, Hsu, and Lee (2012), and Feng (2012). Problematically, all these previous studies assume a single level of cost sharing in the individual health insurance market and set it equal to the coverage rate of employer sponsored group insurance. This simplification ignores the idiosyncrasies of the individual and group markets and abstracts away from the variety of insurance contracts available before and after the implementation of the ACA.

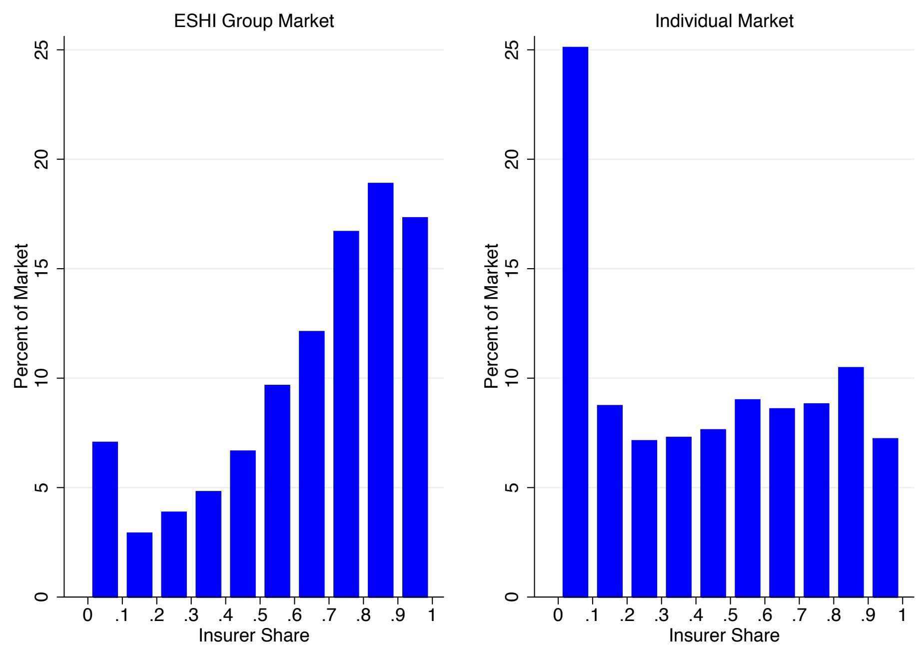
Pre-ACA, the assumption that the cost sharing rate of group and individual insurance are identical is contradicted by data from the Medical Expenditure Panel Survey for the years 2000 to 2010. As shown in Figure (A.1), after controlling for age, education, and the size of the medical expenditure, the group market achieves a higher average level of cost sharing than the individual market. As seen in the left-hand panel, for an individual with low medical expenses, group plans cover just over 60% of expenses as compared to about 40% for individual plans.

Figure A.1: Average Share of Medical Expenses Covered by Private Insurers, by Age and Medical Risk, Only College Educated



The explanation for this observation becomes apparent in light of Figure (A.2), which shows the dispersion of cost sharing levels for the two types of insurance. The distribution of coverage rates in the group market is right-skewed with a mode around 80%. In contrast, the individual market has a relatively uniform distribution except for a large clustering at the left tail, where 25% of enrollees in the individual market have less than 10% of their medical expenses covered.

Figure A.2: Histogram for Share of Medical Expenses Covered by Private Insurers as a Percent of Each Market



As Figure (A.3) demonstrates, the primary reason the individual market enrollees receive such lower coverage is that their expenses do not exceed the deductible of their policy. In a survey of policyholders, individual PPO plans had an average deductible of $2,456 (2009$), compared to a PPO plan in the small group market (firms with 26-50 workers) of $1,390 (2010$).[33,34,35] All told, enrollees in the group market experience

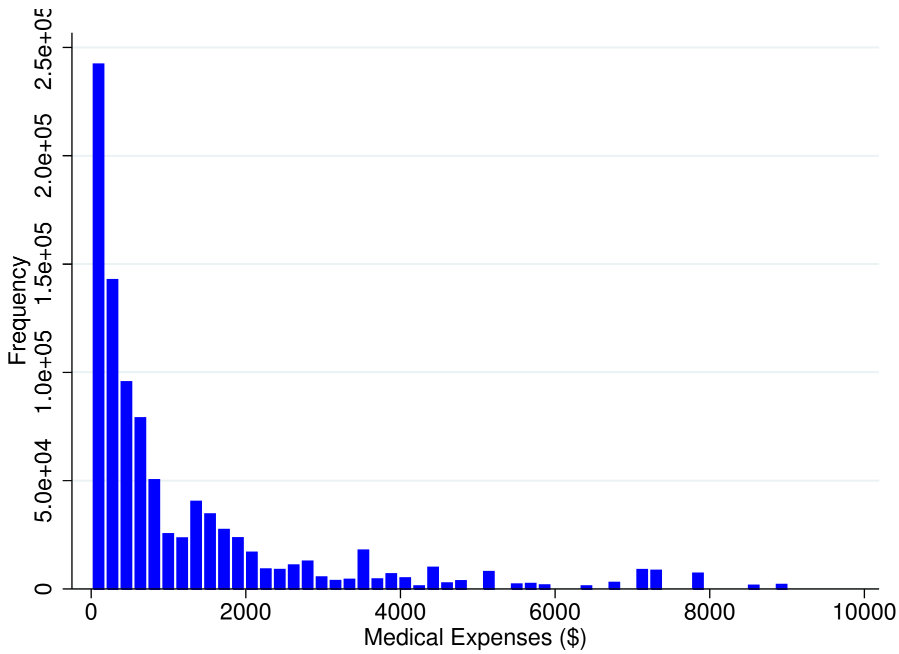
[33]American Health Insurance Plans (AHIP), Individual Health Insurance 2009: A Comprehensive Survey of Premiums, Availability, and Benefits

[34]AHIP, Small Group Health Insurance 2010:A Comprehensive Survey of Premiums, Choices, and Benefits

[35]A PPO is a Preferred Provider Organization, a type of insurer that allows greater choice across

a much higher level of cost sharing than their counterparts in the individual market.

Figure A.3: Histogram of Medical Expenses for Individual Market Enrollees with Cost Share Less Than 10%



Post-ACA, simplifying the individual market to a single coverage level reduces the degree of adverse selection. Under a single coverage level, when a healthier than average enrollee is unwilling to share medical costs with their riskier counterparts, the only alternative is to go uninsured, a risky proposition. By allowing a variety of coverage levels, healthier individuals gain the ability to select away from those plans favored by the high-risk individuals and still remain insured via a plan that cost shares at a lower level.

hospital and doctor networks. PPOs contrast with HMOs (Health Maintenance Organizations), which tend to restrict the physician networks available to enrollees. For the purposes of fair comparison, I compare the deductibles of the more popular PPO plans across individual insurance and ESHI.

A.2 Additional Figures and Tables

Figure A.4: Average Medical Expenses by Age, MEPS 2000-2010

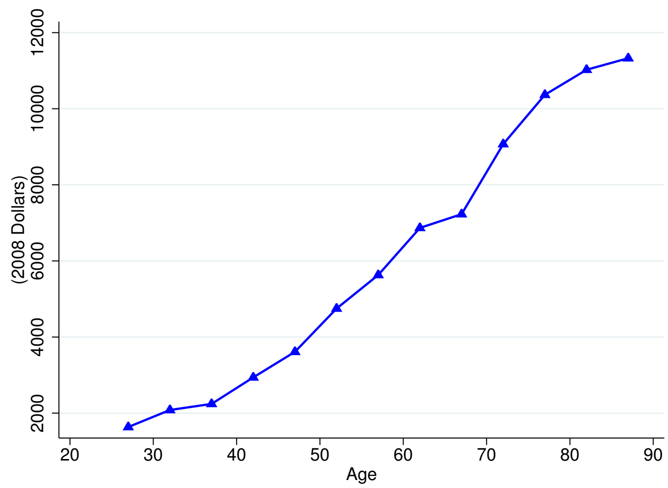


Figure A.5: Medical Expenditure Shocks by Age

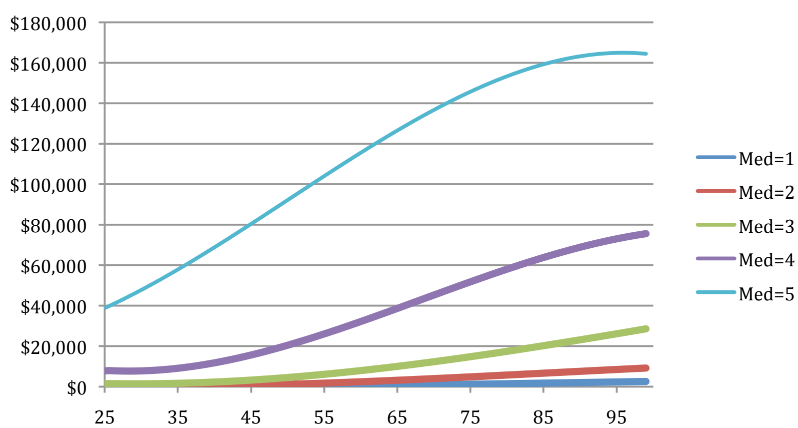


Figure A.6: Medical Expenditure Shocks by Age, Only Med=1,2,3

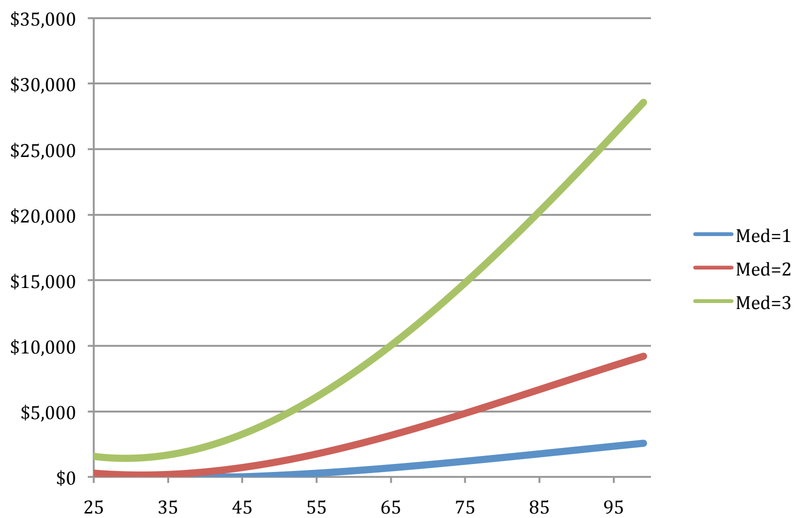


Table A.1: Transition Probabilities Across Medical Expenditure Bins, Working Ages

Year1/Year2	Med=1	Med=2	Med=3	Med=4	Med=5
Med=1	0.637	0.242	0.096	0.022	0.003
Med=2	0.298	0.413	0.239	0.047	0.003
Med=3	0.128	0.298	0.464	0.101	0.008
Med=4	0.084	0.163	0.421	0.302	0.031
Med=5	0.057	0.103	0.248	0.379	0.213

Table A.2: Transition Probabilities Across Medical Expenditure Bins, Retired Ages

Year1/Year2	Med=1	Med=2	Med=3	Med=4	Med=5
Med=1	0.631	0.212	0.121	0.033	0.003
Med=2	0.245	0.420	0.266	0.065	0.004
Med=3	0.121	0.301	0.440	0.128	0.011
Med=4	0.079	0.173	0.457	0.257	0.034
Med=5	0.032	0.135	0.375	0.386	0.072

A.3 Computational Methodology

Algorithm for Computing Pre-ACA Equilibrium

I solve for the steady state equilibrium of the pre-ACA, "full information" model as follows.

1. Begin with an initial guess for the interest rate r, ESHI group premium p_g, amount deducted from wage per effective unit of labor by the firm to pay its share of the ESHI premium, c_E, proportional income tax, τ_y, and bequest B_e.

2. Solve for the households' decision rules using backward induction over a coarse grid.

3. Simulate the households' distribution with the given decision rules.

4. Aggregate and check if market clearing conditions and zero profit conditions for insurance firms hold, and government budget balances.

5. If conditions do not hold, update r, p_g, c_E, τ_y, and B_e, and repeat steps 1-4.

For calibration, after computing the steady state equilibrium I check whether the model matches moments from the insurance and labor market. I update the discount factor, β, fixed cost of underwriting, η, deterministic term for labor productivity, $\lambda_{j,e,m_{j-1}}$, and fixed cost to leisure from working, ϕ_{j,e,m_j}, to match these moments. Then, repeat steps 1-5.

Algorithm for Computing Post-ACA Equilibrium

I solve for the steady state equilibrium of the post-ACA, "partial information" model as follows. Consistent with competitive behavior, the iterative procedure I employ selects the equilibrium yielded by insurer's taking the most optimistic belief regarding the medical expenditure risk of enrollees.

1. To begin, guess the premium prices in the individual market, one for each of the coverage levels at each age. Insurers take the most optimistic beliefs possible for all coverage levels, i.e. that all enrollees are of the lowest medical expenditure

risk category, Med=1, i.e. $m_{j-1} = 1$. So the premiums are calculated as $p^{(0)}(q_j, j) = \gamma EM(m_{j-1} = 1, j)q_j$.

2. Repeat Steps (1) and (2) as in pre-ACA. Solve for the household decision rules to obtain $q_j = f_q(j, e, k_{j-1}, z_{j,e,m_{j-1}}, m_{j-1}, g_j)$ and $S(m_{j-1}|\mathcal{I})$.

3. Repeat Step (3) as in pre-ACA. Simulate the distribution of households, $\Gamma(j, e, k_{j-1}, z_{j,e,m_{j-1}}, m_{j-1}, g_j)$ with the decision rules.

4. Repeat Step (4) as in pre-ACA.

5. In addition to Step (4), for all q_j that are observed, i.e. $\varphi(q_j) > 0$, use $S(m_{j-1}|\mathcal{I})$ and $\Gamma(j, e, k_{j-1}, z_{j,e,m_{j-1}}, m_{j-1}, g_j)$ to compute $Pr(m_{j-1}|\mathcal{I})$. The calculation changes depending on the pooling arrangement in place.

   (a) Separate Risk Pools:

      i. $Pr(m_{j-1}|\mathcal{I}) = Pr(m_{j-1}|q_j, j) = \int_{S(m_{j-1}|q_j,j)} d\Gamma(j, e, k_j, z_{j,e,m_{j-1}}, m_{j-1}, g_j)$ is the conditional probability of having state $m_j - 1$ given the observables (q_j, j).

      ii. The insures then separately formulates an expectation of medical expenditures for each coverage level as $EM(q_j, j) = \int_{m_{j-1}} \left[\int_{m_j} max\Big\{0, m_j - d\Big\}\Omega(m_j|m_{j-1}, j)\right] Pr(m_{j-1}|q_j, j)$.

      iii. Compute the intermediate price function for the break-even premium as $\hat{p}(q_j, j) = \gamma EM(q_j, j)q_j$.

      iv. If a coverage level is not chosen and there is no higher coverage level chosen, i.e. $\varphi(q_j) = 0$ and $\varphi(q_j^+) = 0 \quad \forall q_j^+ > q_j$, then leave the premium unchanged, $\hat{p}(q_j, j) = p^{(0)}(q_j, j)$.

      v. Otherwise, if a coverage level is not chosen by any household, i.e. $\varphi(q_j) = 0$, but some higher coverage level is chosen, $q_j^+ > q_j$ and $\varphi(q_j^+) > 0$, then find the next lowest coverage rate, $q_j^- < q_j$, which is chosen, $\varphi(q_j^-) > 0$, and calculate the intermediate premium as $\hat{p}(q_j^-, j) = \gamma EM(q_j^-, j)q_j$.

   (b) Single Risk Pool

i. $Pr(m_{j-1}|\mathcal{I}) = Pr(m_{j-1}|j, \mathbf{1}_{q_j \in IND}) = \int_{S(m_{j-1}|j,\mathbf{1}_{q_j \in IND})} d\Gamma(j, e, k_j, z_{j,e,m_{j-1}}, m_{j-1}, g_j)$ is the conditional probability of having state $m_j - 1$ given the observables $(j, \mathbf{1}_{q_j \in IND})$.

ii. The insures hold the same expectation of medical expenditures for each coverage level and compute expect medical expenses above deductible as $EM(j, \mathbf{1}_{q_j \in IND}) = \int_{m_{j-1}} \left[\int_{m_j} max\Big\{0, m_j - d\Big\} \Omega(m_j|m_{j-1}, j) \right] Pr(m_{j-1}|j, \mathbf{1}_{q_j \in IND})$.

iii. Compute the intermediate price function for the break-even premium as $\hat{p}(j, \mathbf{1}_{q_j \in IND}) = \gamma EM(j, \mathbf{1}_{q_j \in IND}) q_j$.

(c) Set $p^{(1)}(q_j, j) = \Xi p^{(0)}(q_j, j) + (1 - \Xi)\hat{p}(q_j, j)$, where Ξ is set close to 1, and repeat Steps (2)-(5) until premiums for each coverage level converge. Given the potential for multiple equilibria, I am starting the premiums too low, then slowly raising them up until they converge within a specified tolerance.

Discussion of Off Equilibrium Path Beliefs

The following discussion is only relevant to the post-ACA ‘separate risk pool’ scenario. In the ‘single risk pool’ scenario a full set of premium prices can be constructed so long as a single individual of each age purchases any plan on the individual market because the expected medical risk is the same across all plans under a single risk pool. Even without the subsidy or penalty, adverse selection never completely unwinds the individual market. With separate risk pools, the issue emerges of how to price a premium when no household selects the plan, i.e. off the equilibrium path.

The multiplicity of equilibria is a well-documented issue in signaling games of asymmetric information (see Cho and Kreps 1987). Since the definition of a perfect Bayesian equilibrium does not restrict off equilibrium path beliefs, the absence of such restriction allows the modeler to dictate the selection of equilibria. To supply a trivial example, suppose the insurer assumes the highest possible medical expenditure risk for all coverage levels and at the corresponding premiums no household purchases insurance. In this way pessimism can be self-fulfilling. Thus, a discussion of how the iterative procedure described above generates premium prices for plans that are not chosen is germane.

Suppose there exists a continuum of competitive insurers with different beliefs regarding the medical expenditure risk of households who would purchases an individual plan at each coverage level and age. Consistent with competitive behavior, each insurer offers a break-even premium at each age and coverage level based on their beliefs. Optimal behavior by households dictates that they select the plan with the lowest premium at the coverage level desired. If the beliefs of the lowest premium insurer are too "optimistic", i.e. the medical expenditure risk of the plan's enrollees exceeds what was expected, the costs to the insurer will exceed the revenue generated from the premiums and that insurer exits the market. In this manner, I select the equilibrium corresponding to the assumption that insurers take the most optimistic expectation of enrollees risk possible and make zero profit.

To begin the iterative procedure, I generate a guess for the premiums in the individual market corresponding to all enrollees having the lowest possible medical expenditure risk. That is, insurers completely ignore the possibility that a higher risk type would purchase their plan. The first guesses for the premiums at each coverage level are calculated as $p^{(0)}(q_j, j) = \gamma EM(m_{j-1} = 1, j)q_j$. I then proceed through Steps (1) to (5) as detailed above.

If a plan is selected then the break-even premium can be calculated by measuring the likelihood of each risk type who bought the plan. The problem arises when no household selects a plan, i.e. a "hole" opens up in the pricing function. There are two types of "holes" that can emerge. The first type is when the "hole" is at an endpoint, where no household buys that plan or any higher coverage one. In this case, successive iterations have raised the premium of that plan and due to adverse selection the premium rose to a point where all the consumers departed for lower coverage plans. In this case I leave the premium unchanged, i.e. if $\varphi(q_j) = 0$ and $\forall q_j^+ > q_j$, then, $\hat{p}(q_j, j) = p^{i-1}(q_j, j)$, because as the premiums of lower coverage plans rise, some consumers may wish to switch back to the higher coverage plan. If the consumers want to switch to the previously unchosen plan they must be willing to pay at least the price that emptied the market.

The second type of "hole" occurs at a midpoint, where relatively higher and lower coverage levels are chosen. Since households are risk averse, medical expenditure risk is increasing in desired coverage level. Therefore, for this “hole” the premium is calculated as function of the medical expenditure risk at the next lowest chosen coverage level. More formally, if $\varphi(q_j) = 0$ and $\exists q_j^+ > q_j$ and $\exists q_j^- < q_j$ such that $\varphi(q_j^+) > 0$ and $\varphi(q_j^-) > 0$ then $\hat{p}(q_j^-, j) = \gamma EM(q_j^-, j)q_j$. This method guarantees that insurers hold the most optimistic view of enrollees even for plans not chosen in equilibrium.

Note, households are never directly confronted with the break-even premium because premium prices are held below the equilibrium by the very slow updating of the pricing function. As shown in Step (6), I set $p^{(1)}(q_j, j) = \Xi p^{(0)}(q_j, j) + (1 - \Xi)\hat{p}(q_j, j)$, with $\Xi = 0.985$.

In the steady state of the ‘separate risk pools’ scenario only the endpoint type “holes” are observed. Based on the iterative procedure, insurers believe that the type of individual who would purchase the highest coverage plans is of the highest medical risk. While not provable, this equilibrium would seem to satisfy the Intuitive Criteria of Cho and Kreps (1987) that off equilibrium path beliefs are reasonable. Even if insures believe a deviation to the highest coverage level has zero probability, the payoff yielded to the highest risk type is below that received on the equilibrium path because of the benefit gained by risk sharing with lower types.

Chapter 2

The Bills of Health: The Affordable Care Act and Personal Bankruptcy

2.1 Introduction

Medical bills and income loss from medically related job separations are two of the most commonly cited causes of bankruptcy in the United States. On the high end of estimates, Himmelstein et al. (2009) claim that medical expenses and income loss from illness cause 62.1% of all bankruptcies. More conservatively, Sullivan, Warren, and Westbroook (2000) find that 19.3% of bankruptcies are directly attributable to medical bills, while 67.5% of bankruptcies are due to unemployment. How much of that unemployment is caused by illness is not certain. The fact remains that large out-of-pocket medical expenses cause severe financial stress on households. By discharging unsecured debt, bankruptcy offers a form of health insurance. But such action entails significant pecuniary costs, such as lawyer and court fees, and non-pecuniary costs, such as embarrassment, stigma, and future difficulty obtaining contracts that require a good credit history, e.g. renting an apartment. Furthermore, while the defaulting household is able to discharge their medical debt, the financial loss to medical goods and service providers must be recovered, often times by shifting the costs on to paying customers. The objective of this research is to determine how the Patient Protection and Affordable Care Act's (ACA) health insurance regulations affect the instance of bankruptcy and measure the associated welfare changes.

To analyze the relationship between health insurance and bankruptcy, I build upon the general equilibrium life cycle model with insurance choice as described in LaCerda (2016) by incorporating household borrowing and default. Households are endowed with education at the beginning of their lives which determines their average income during working years and the likelihood of receiving insurance from their employer. Their utility is a function of consumption and leisure. Households face idiosyncratic productivity and medical expenditure shocks. The medical shocks affect the size of future productivity draws, leisure time, and the probability of survival. Insurance against the medical expenditure shock is available in three forms: (1) employer sponsored group health insurance (ESHI), (2) private individual market health insurance, and (3) public insurance. The ESHI offering firm pools participating employees across all ages and medical risk types and offers a single plan with a uniform premium. Pre-ACA, the individual market offers a variety of plans with different coverage rates, but the premiums are conditioned on individual medical expenditure risk. Both of these private insurance options are competitively priced. Public insurance is only available to retired households, i.e. Medicare, and households with sufficiently low income, i.e Medicaid. In addition to operating the public insurance programs, the government also provides transfer payments to low income households, i.e. SNAP, EBT, TANF, etc., and retired households, i.e. Social Security.

The setup of the asset market, the financial intermediary's problem, and the costs of default follow Chatterjee et al. (2007) and Athreya, Tam, and Young (2012). A competitive financial intermediary rents capital to firms, takes deposits, and makes loans. When households save they earn the risk free interest rate. When households borrow, the price, i.e. discount rate, of the loan depends on the amount of debt desired and the individuals state variables. The competitive financial intermediary is assumed to have perfect information and uses the household's current state and decision rules to forecast their default probability when pricing loans. By defaulting a household discharges their debt and out-of-pocket medical expenses, but incurs pecuniary and non-pecuniary costs. To account for the unpaid medical bills, hospitals place a markup on the out-of-pocket medical expenses of households that do not default. By assumption, insurers always pay their share of the medical bill. Hospitals do not produce medical goods or services but merely act as a transfer mechanism.

I calibrate the pre-ACA version of the model using data from the Medical Expenditure and Panel Survey (MEPS) 2000-2010, Survey of Consumer Finances 2007 (SCF), and the Consumer Bankruptcy Project 2008 (CBP). I use the MEPS data to calculate the size of medical expenditure shocks, survival probabilities, income, employment rates, and market shares of the different insurance options. The SCF and CBP data is used to calculate default rates, net worth, and interest rates.

To transform the model to the post-ACA setting, I incorporate the law's regulations on premium pricing, subsidies, penalties, and public insurance expansion. The premium pricing regulation forbids insurers from conditioning premiums on medical expenditure risk. Instead, the insurer must pool households by age and price premiums for the different coverage levels according to the average expected medical expenditure risk of each age. For low income households, the ACA provides premium subsidies, which limit the size of the premium to a certain fraction of income, and cost sharing subsidies, which reduce households' out-of-pocket expenses. The ACA also mandates penalties for households that go uninsured and raises the income threshold for public insurance eligibility.

I find that the ACA causes a significant decline in the number of bankruptcies. The default rate of the total population falls from 1.00% to 0.63%, a 37% decline in the total number of households filings for bankruptcy. With over one million personal bankruptcy filings each year (according to the American Bankruptcy Institute), the model predicts that the ACA will result in over 300,000 fewer households defualting.[1] The reduction in bankruptcy is being driven by the increase in insurance. The ACA lowers the uninsured rate from 21.4% to 2.4%, with most of the newly insured participating in the individual market. The sharp increase in the number of insured reduces the aggregate amount of out-of-pocket medical expenses, causing the number of households with negative net worth to fall from 13.2% to 11.1%. The decline in default rates is most pronounced for households with less than a high school education, whose rate falls from 1.7% to 1.1%. Not coincidently, this least educated cohort also experiences the largest reduction in the share of people going uninsured, down

[1] http://abi-org.s3.amazonaws.com/Newsroom/Bankruptcy_Statistics/Quarterlynonbusinessfilings1994-Present.pdf

to 3.3% from 30.3%.

The reduction in default probabilities also lowers the average interest rate on loans, from 20.6% to 17.4%. Lower interest rates encourage more borrowing, as shown by the increase in the ratio of aggregate negative net worth to GDP from 0.49% to 0.57%. Since net worth is measured as assets minus out-of-pocket medical expenses, based on the previous statistic the rise in borrowing must exceed the decline in out-of-pocket medical expenditures from more insurance. The reduction in out-of-pocket expenses also causes households to discharge less debt when they do default. The ratio of the mean amount of unsecured debt discharged in bankruptcy to the mean of household income falls from 0.52 to 0.49, a drop of roughly 6%. With fewer defaulters and smaller amounts of negative net worth being discharged, the markup charged by hospitals to cover unpaid medical bills drops from 10.5% to 7.3%. The lower markup relaxes the budget constraint of households, increasing consumption. With the decline in interest rates on loans, the cost of consumption smoothing falls too. All told, the changes brought by the ACA result in a 2.12% increase in overall welfare, as measured by the consumption equivalent variation of newborn households. Despite slight changes to the calibration, the welfare increase is modestly larger than the result recorded in LaCerda (2016), the model without borrowing. The additional transmission channels of the hospital and interest rates are driving the relatively larger welfare gain.

Previous literature has focused on the relationship between health insurance and bankruptcy, but little has focused on the regulations of the ACA. Much more attention has been paid to the effect of public insurance expansions on bankruptcy and the literature reveals a near unanimous agreement. Gross and Notowidigo (2011) estimate that a 10% increase in Medicaid eligibility reduces bankruptcy by 8%. Using data from the Oregon Medicaid Experiment, Finkelstein et al. (2011) finds that a 25% increase in Medicaid enrollment caused a 6.4% decline in the probability of an unpaid medical bill being sent to collection agencies. Public insurance expansions, like the one incorporated in the ACA, reduce defaults and overdue bills.

The literature on private insurance expansions is less consistent. Using data from the periods before and after the Massachusetts health care reform, Mazumder and Miller (2014) estimate that for each 1% increase in the insured rate, the bankruptcy rate falls by 0.03%. Using data from the same reform episode, Badding et al (2012) reaches the opposite conclusion that the Massachusetts reform increased bankruptcy by 0.04% for every 1% increase in the insured rate. Explaining the contradictory findings, while insurance reduces the size of out-of-pocket medical expenses and lowers the probability of bankruptcy, the provision of insurance could also diminish the precautionary savings motive, raising the probability of default.

Two recent studies have focused on the ACA and bankruptcy and reached opposing conclusions. In a general equilibrium framework, Kuklik (2011) finds that the ACA only reduces the total bankruptcies by 6%. In contrast, Fischer (2014), with a general equilibrium model more similar to this one, finds a more significant 59% decline in personal bankruptcies. The 37% decline in bankruptcies in my model is more in line with the latter findings. Kuklik (2011) explains their result by noting that the decline in bankruptcies brought by the increase in insurance, reduces the probability of default, which lowers interest rates, and encourages more borrowing. The additional borrowing increases defaults by an amount significant enough to almost completely offset the decline from more insurance. The same phenomenon appears in my model, but the increase in borrowing is not nearly as significant.

The remainder of this paper is organized as follows. Section 2.2 details the structure of the model. Section 2.3 describes the data and calibration of the model's parameters. Section 2.4 compares the performance of the pre-ACA model to the data. Section 2.5 analyzes the ACA's changes to default, borrowing, insurance choice, aggregate economic measures, and welfare. Section 2.6 concludes.

2.2 The Model

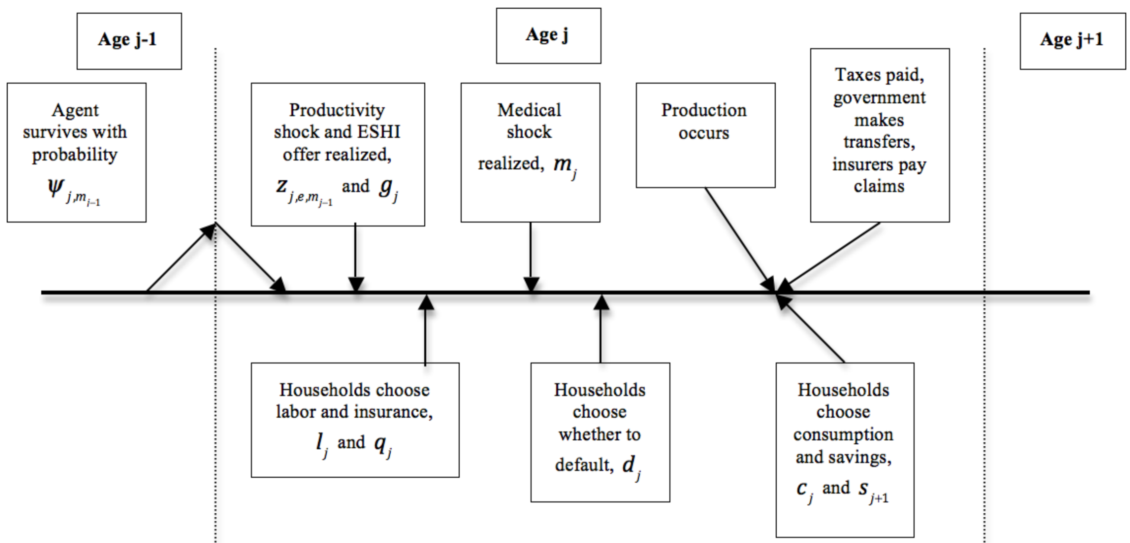
The following closely adheres to the structure of the model set forth in LaCerda (2016) with the addition of borrowing and household default. In this section I first describe the timing of the model. After describing the shocks faced by the household and their optimization problem, I discuss loan pricing and the financial intermediary's problem, insurers' premium pricing behavior, the hospital's problem, the firm's optimization problem, and the government's budget constraint. I conclude with a description of the competitive equilibrium. To ease the notation I dispense with indexing the households by i.

2.2.1 Timing

The agents in the model are households, firms, financial intermediaries, hospitals, health insurers, and the government. The timing of shocks and decisions is summarized in Figure (2.1). Households are endowed with education, e, at the beginning of their lives. Individuals' age is indexed by j. $\psi_{j,m_{j-1}}$ is the probability of surviving from age $j-1$ to j and is a function of age and previous medical shock, m_{j-1}. Surviving agents receive a productivity shock, $z_{j,e,m_{j-1}}$, and exogenous ESHI group offer, g_j. With knowledge of these two shock agents choose their labor supply, l_j and health insurance coverage rate, q_j.

The second stage of the period begins with households receiving their medical expenditure shock, m_j. At this juncture households choose whether or not to default, d_j, which completely discharges their debt and medical bills. Following the default decision, the following events occur simultaneously. Production occurs where capital is paid a rental rate, r, and labor is paid a wage per effective unit, w. These prices are determined in equilibrium. The government collects income, payroll and consumption taxes, makes transfers for the retired (hereafter referred to as Social Security), public insurance (Medicare and Medicaid), and social assistance. Households choose consumption, c_j, and next period's savings, s_{j+1}. Households are allowed to borrow, i.e choose negative savings, $s_{j+1} < 0$.

Figure 2.1: The Timing of Shock and Decisions in the Model



2.2.2 Households

Demographics and Preferences

The economy consists of a unit measure of overlapping generations of households, working-age and retired, who live a maximum of $J < \infty$ periods. Individuals choose whether to work or not in the first $j^* - 1$ periods of life. Though agents may depart the labor force earlier, retirement is exogenously enforced at age j^*. In retirement, individuals live off of savings, Social Security, and Medicare. Individuals of age $j - 1$ survive to age j with probability $\psi_{j,m_{j-1}}$, which depends on their age and last period's medical shock, m_{j-1}. Smaller medical shocks are correlated with a higher likelihood of survival. The assets of all deceased individuals are pooled by education and then uniformly redistributed to working age households according to educational status in an amount B_e. Individuals have a pure time discount factor of β. Individuals are endowed with education, e, at the start of their lives. Education determines average productivity during households' working years.

Following Athreya, Tam, and Young (2012), agents who default suffer a non-pecuniary cost of default, $\kappa_{e,j}$, which depends on education level. The cost is incorporated as a multiplicative factor in the utility function. The basis for its inclusion is justified by Gross and Souleles (2002), Fay, Hurst, and White (1998), who document the existence of households who would financially benefit from declaring bankruptcy but choose not to default. Furthermore, Athreya (2002) shows that a large number of the costs associated with bankruptcy are non-pecuniary, such as the social stigma or embarrassment and the difficulty in obtaining contracts that require good credit history, e.g. renting an apartment.

Households' preferences over consumption and leisure are given a Cobb-Douglas specification. Utility over the composite is given an isoelastic form of

$$u(c_j, l_j) = \frac{(\kappa_{e,j} c_j^{\chi}(1 - l_j - \mathbf{1}_{\{l_j>0\}}\phi_{j,e,m_j})^{1-\chi})^{1-\sigma}}{1-\sigma} \tag{2.1}$$

which is a function of consumption, leisure, and a fixed cost to leisure which depends on the medical expenditure shock, explained later. $\frac{1}{\sigma}$ is the intertemporal elasticity of substitution. χ is the parameter determining the relative importance of consumption and leisure. ϕ_{j,e,m_j} is the fixed cost to leisure of working and depends on age and the medical shock.

For households who default, the non-pecuniary cost is $0 < \kappa_{e,j} < 1$, otherwise, if no default, $\kappa_{e,j} = 1$. The non-pecuniary cost of default evolves stochastically according to an AR(1) process. A higher value of $\kappa_{e,j}$ increases the likelihood of default because the "tax" on consumption will be smaller, as will the corresponding utility loss.

Productivity and ESHI Group Offer

Productivity at age j is given by $z_{j,e,m_{j-1}}$, which is the log sum of a deterministic term, $\lambda_{j,e,m_{j-1}}$, and two shocks. υ_j, is a persistent, AR(1) shock. ζ_j, is white noise. The deterministic term determines the mean of income at each age for each education and medical cohort. Productivity can be expressed as

$$\begin{gathered} z_{j,e,m_{j-1}} = \lambda_{j,e,m_{j-1}} exp(\upsilon_j) exp(\zeta_j) \\ \text{where} \quad \upsilon = \rho_z \upsilon_{j-1} + \epsilon_j^z, \quad \epsilon_j^z \sim N(0, \sigma_z^2), \quad \text{and} \quad \zeta_j \sim N(0, \sigma_\zeta^2). \end{gathered} \tag{2.2}$$

ρ_z is the persistence parameter in the AR(1) process. Total labor income can be written as $\widetilde{w} l_j z_{j,e,m_{j-1}}$. Workers not in the ESHI group market earn $\widetilde{w} = w$, where w is wage per effective unit of labor. The workers in the ESHI group receive a wage per effective unit of labor of $\widetilde{w} = w - c_E$, where c_E is a deduction used to finance the firm's share of the ESHI premium.

A working age agent also receives an exogenous offer to work at a firm that offers ESHI group insurance, $g_j = 1$, or a non-ESHI group insurance offering firm $g_j = 0$. The probability of getting either offer depends on education, income, and the previous period's offer status. With knowledge of these shocks individuals choose their labor supply, $l_j \in \{0, l_{PT}, l_{FT}\}$, which correspond to unemployment, part-time employment, and full-time employment, respectively.

Pre-ACA Insurance Choices and Premiums

Before the realization of the medical expenditure shock, m_j, and simultaneous to the labor supply decision, agents choose, q_j, i.e. the share of their medical expenses above a deductible, b, to be covered by the insurer. Health insurance contracts only differ along the q_j dimension. Out-of-pocket medical expenses, $O(m_j, q_j)$, of a working age individual age j can be written as

$$O(m_j, q_j) = (1 - q_j)max\{0, m_j - b\} + min\{m_j, b\}. \tag{2.3}$$

The total amount paid by households is $(1 + h)O(m_j, q_j)$, where h is a markup that hospitals place on out-of-pocket medical expenses in order to recover the losses they suffer from medical bills discharged in default. Regardless of the household's default decision, the insurer always pays their portion of the medical expenditure shock. By assumption, the markup is only placed on households' out-of-pocket expenses, and thus the markup does not directly affect premium pricing. However, if the ACA reduces default then the benefit is shared across all individuals, insured and uninsured, as a lower required markup would reduce the total out-of-pocket expense.

In the pre-ACA individual market, the choice set of coverage rates are $q_j \in (0, 1]$. $q_j = 0$ corresponds to going uninsured. In the ESHI group market the choice set is $q_j \in \{0, q_g\}$. Only individuals working full-time at the ESHI offering firm, i.e. $g_j = 1$ and $l_j = l_{FT}$, can participate in the group market.

The price of the health insurance premium is p. In the individual market the premium, $p = p(q_j, \mathcal{I})$, is conditioned on the desired level of coverage and observable, individual specific information, $\mathcal{I}$. Thus premiums vary according to an individual's medical expenditure risk. The group market pools all enrollees and charges a uniform premium, $p = (1-\mu)p_g$, where μ is the share of the premium covered by the employer. The ESHI premium is tax deductible. Working age individuals whose total taxable income, y_j, is below a certain threshold, y_{mcd}, are automatically enrolled in public insurance (hereafter referred to as Medicaid), where $p = 0$ and $q_j = q_{mcd}$. Retired individuals are automatically enrolled in public insurance (hereafter referred to as the Medicare), where $p = p_{mcr}$ and $q_j = q_{mcr}$. Private individual and group insurance have a deductible. I assume Medicare and Medicaid do not have a deductible. Agents are committed to these contracts prior to the medical expenditure shock and pay their premium when they receive their income. There is no type of cash in advance constraint on insurance choice. The owed premium cannot be discharged in bankruptcy.

Medical Expenditures

After committing to an insurance contract, an individual receives an exogenous, medical expenditure shock, m_j, which evolves according to a Markov process, $\Omega(m_j|m_{j-1}, j)$. The shock depends on age and the previous medical expenditure shock. The medical expenditure shock influences the decisions of agents through multiple transmission channels. Not only do medical expenditures enter the household's budget constraint, they also affect survival probability, next period's productivity, and utility from leisure while working. Because the government provides health insurance for the elderly and needy through Medicare and Medicaid, these medical shocks also influence the income tax rate.

Default Decision

Following the medical expenditure shock, the household decides whether or not to default, d_j. $d_j = 1$ signifies default and $d_j = 0$ corresponds to no default. By assumption, partial defaults are not allowed. As mentioned before, households who default suffer a non-pecuniary cost, $\kappa_{e,j}$. In addition, individuals who default must also pay a pecuniary cost, Δ. The presence of this pecuniary cost is meant to represent the expenses for lawyers and court filing costs necessary to filing for bankruptcy.

If a household defaults, then their savings/debt and out-of-pocket medical expenses are completely discharged, i.e. $s_j = 0$ and $O(m_j, q_j) = 0$. All borrowing in the model is unsecured credit. The models abstracts away from collateralized debt and treats borrowing akin to credit card use. By not surviving to the next period the household automatically defaults. Agents who default are still required to pay taxes and their health insurance premiums. Households who default are not allowed to borrow or save in the current period, $s_{j+1} = 0$, as is consistent with bankruptcy courts' practices. Households regain access to credit markets in the following period. If the household discharges debt, i.e. $s_j < 0$, then the financial intermediary takes the loss. If the household declares default while holding a positive amount of savings, $s_j > 0$, because the benefit of discharging the out-of-pocket medical expenses and paying the associated costs is greater than the loss of assets, then the hospital recovers the positive assets.

Because I will assume that the financial intermediary has perfect information there is no need to include a "credit history report" for individuals in the model. Knowledge of the household's current state variables provides all the information necessary for the financial intermediary to forecast the probability of default.

Optimization Problem

After the default decision is made, the agent chooses next period's savings/borrowing, $s_{j+1} \in \mathbb{R}$, and consumption, $c_j \in \mathbb{R}^+$, while the government charges all individuals a progressive income tax, $T(y_j)$, a proportional income tax, τ_y, and a proportional consumption tax, τ_c. Working individuals also pay proportional Social Security, τ_{ss}, and Medicare, τ_{mcr}, payroll taxes, i.e. on labor income only. At age j the state space of the working age household can be written as $(j, e, s_j, z_{j,e,m_{j-1}}, m_{j-1}, g_j, \kappa_{e,j})$ and the choice variables of the household are $(q_j, l_j, d_j, s_{j+1}, c_j)$. A description of the retired household follows the working age household.

Working age ($j < j^*$) households' value function can be written as

$$\begin{aligned} &V(j, e, s_j, z_{j,e,m_{j-1}}, m_{j-1}, g_j, \kappa_{e,j}) = \\ &\max_{q_j, l_j, d_j, s_{j+1}, c_j} u(c_j, l_j) + \beta \psi_{j+1,m_j} E\Big[V(j+1, e, s_{j+1}, z_{j+1,e,m_j}, m_j, g_{j+1}, \kappa_{e,j+1})\Big] \end{aligned} \tag{2.4}$$

subject to

$$\begin{aligned} (1-d_j)s_j + \widetilde{w} z_{j,e,m_{j-1}} l_j + T_{SI} + B_e \geq \\ (1-d_j)x_i s_{j+1} + (1+\tau_c)c_j + (1-d_j)(1+h)O(m_j, q_j) + Tax + p + \Delta d_j \end{aligned} \tag{2.5}$$

and

$$\begin{aligned} Tax = T(y_j) + \tau_y y_j + \tau_{mcr}(\widetilde{w} z_{j,e,m_{j-1}} l_j - \mathbf{1}_{\{q_j = q_g\}} p) \\ + \tau_{ss}\Big(max\{\widetilde{w} z_{j,e,m_{j-1}} l_j - \mathbf{1}_{\{q_j = q_g\}} p, \overline{y}_{ss}\}\Big) \end{aligned} \tag{2.6}$$

where $y_j = (1-d_j)(1-x_{-i})s_j \mathbf{1}_{s_j > 0} + \widetilde{w} z_{j,e,m_{j-1}} l_j - \mathbf{1}_{\{q_j = q_g\}} p$ is taxable income. Interest income is taxable, but interest paid on unsecured debt is not tax deductible. By law, only mortgage and student loan interest is tax deductible, both of which are forms of secured debt. As explained in more detail with the description of the financial intermediary, x_i is the individual specific discount rate applied to savings/borrowing. Households choose to save or borrow $x_i s_{j+1}$ in the current period and receive s_{j+1} in the next period. B_e is the education specific bequest. Per law, the premium on group health insurance is tax deductible and the social security payroll tax is only charged on income below a certain threshold, $\overline{y}_{ss}$. T_{SI} represents the lump sum transfer from the government's social assistance program. If an individual's income, y_j is below a certain threshold, $y_{\underline{c}}$, then the program transfers $\underline{c}$ to the household. The size of the transfer is sufficient that if the agent chooses to default they will be able to pay the pecuniary cost of default.

$$T_{SI} = \underline{c} \mathbf{1}_{y_j < y_{\underline{c}}}. \tag{2.7}$$

Retirement age ($j \geq j^*$) households' value function can be written as

$$V(j, e, s_j, m_{j-1}, \kappa_{e,j}) = \max_{d_j, s_{j+1}, c_j} u(c_j) + \beta \psi_{j+1,m_j} E\Big[V(j+1, e, s_{j+1}, m_j, \kappa_{e,j})\Big] \tag{2.8}$$

subject to

$$
\begin{aligned}
&(1-d_j)s_j + ss_e + T_{SI} \geq \\
&\qquad x_i s_{j+1} + (1+\tau_c)c_j + (1-d_j)(1+h)m_j(1-q_{mcr}) + Tax + p_{mcr} + \Delta d_j
\end{aligned} \tag{2.9}
$$

and

$$Tax = T(y_{j,ret}) + \tau_y y_{j,ret} \tag{2.10}$$

where $y_{j,ret} = (1-d_j)(1-x_{-i})s_j \mathbf{1}_{s_j>0} + ss_e$ is taxable income of a retired household. ss_e is the Social Security transfer, which depends on education. Per law, Social Security transfers are a function of lifetime earnings, but to improve the tractability of my model I compute the size of the transfer as a fraction, i.e. the Social Security replacement rate, of the average income for each educational group. The formula for calculating eligibility for social assistance is the same as for working-age households.

To ease notation, let the space of the household's state variables be defined by N, i.e. the set of all combinations of $n = (j, e, s_j, z_{j,e,m_{j-1}}, m_{j-1}, g_j, \kappa_{e,j})$ for a working-age household and $n = (j, e, s_j, m_{j-1}, \kappa_{e,j+1})$ for a retired household. Let $\Gamma(N)$ be defined as the distribution of households over this space.

2.2.3 The Financial Intermediary and Loan Pricing

The description of the financial intermediary is based on Athreya, Tam and Young (2012) and Chatterjee et al. (2007). The financial intermediary operates by collecting new savings and old debts, with interest, from households and old capital, with rent, from firms. It uses these resources to purchase new capital, which it lends to firms, make new loans to households, and pay out old deposits, with interest. The financial intermediary receives the previously rented amount of old capital, plus the rental fee minus depreciation, i.e. $(1-\delta+r)K_t$. The financial intermediary rents K_{t+1} amount of new capital to firms. In addition the intermediary pays out the net amount of old savings and non-defaulted loans, $\int_{n\in N}(1-d_j)s_j$. The intermediary also receives new savings net new loans, $\int_{n'\in N} x_i s_{j+1}$. Thus the period-t cash flow of the financial intermediary can be written as

$$(1-\delta+r)K_t - K_{t+1} - \int_{n\in N}(1-d_j)s_j + \int_{n'\in N} x_i s_{j+1} \tag{2.11}$$

where x_i is the discount rate applied to new savings and loans.

The discount rates offered to households, $0 < x_i < 1$, are determined in the following manner. Loan prices are parametric and are determined by the function $x_i(s_{j+1}, \mathcal{I})$, where s_{j+1} is the amount to be delivered to or paid by the household. $\mathcal{I}$ is the information the financial intermediary has on the borrower/saver's current state. I assume that the financial intermediary has perfect information and can observe the entire state space. The pricing of the savings and loans follows Chatterjee et al. (2007) and Athreya, Tam, and Young (2012).

The financial market is perfectly competitive and, as such, the intermediaries will make zero profits. If the household decides to save, $s_{j+1} > 0$, then default is irrelevant to the intermediary because the hospital would take possession of the household's assets in that circumstance. Thus, savings will earn the risk free rate, i.e. the rental rate on capital r. In other words, to receive s_{j+1} amount of resources in the next period, a household must pledge $\frac{1}{1+r}s_{j+1}$ today.

In the case that the financial intermediary is lending to a household, $s_{j+1} < 0$, then the break-even discount rate is given by a function of the probability of default, $\pi(n)$. Default can happen by choice or death. Thus, the break-even pricing of a loan is $x_i = \frac{(1-\pi(n))\psi_{j+1,m_j}}{1+r+\omega}$, where ω is the proportional transaction cost of borrowing. The pricing of savings and loans can be summarized by

$$x_i(s_{j+1}, \mathcal{I}) = \begin{cases} \frac{1}{1+r}, & \text{if } s_{j+1} \geq 0 \\ \frac{(1-\pi(n))\psi_{j+1,m_j}}{1+r+\omega} & \text{if } s_{j+1} < 0 \end{cases}. \tag{2.12}$$

The loan pricing locus is a function of $\mathcal{I}$ because the probability of default $\pi(n)$ and the survival probability ψ_{j+1,m_j} are individual specific. The survival probability is exogenous, however the default probability is endogenous. But since the intermediary has perfect information, they know with certainty under what future states the household will default and the transition probabilities to those states. Thus the default probabilities can be written as

$$\pi(n) = \int_{n' \in N} \Pr(n'|n) d_{j+1}(n') \tag{2.13}$$

where $\Pr(n'|n) = \Pr(z'|z)\Pr(g'|g)\Pr(\kappa'|\kappa)\Pr(m'|m)$ is the probability of transitioning to state n' conditional on current state n and $d_{j+1}(n')$ is the decision rule for default as a function of the future state. Given the solution method of the model is backwards induction, this object is straight forward to calculate.

The objective of the intermediary is to maximize the present discounted value of all future cash flows. Following Chatterjee et al. (2007), under the assumption of perfect competition, the present discounted value is zero and the steady state equilibrium condition of the intermediary can be written as

$$K^* = \int_{n' \in N} x_i^* s_{j+1}^*. \tag{2.14}$$

2.2.4 Premium Pricing

Pre-ACA Premium Pricing

Here I provide a summary of the premium pricing by insurers. Recall, in the individual market agents choose a coverage rate, q_j, for medical expenses above a deductible, b, and view premium prices as parametric, and given by the function $p(q_j, \mathcal{I})$. In the pre-ACA setting $\mathcal{I} = (j, e, s_j, z_{j,e,m_{j-1}}, m_{j-1}, g_j, \kappa_{j,e})$. Since the medical expenditure shock is given by a Markov process, $\Omega(m_j|m_{j-1}, j)$, insurers only need to know (m_{j-1}, j) to price premiums. Expected medical expenditures above the deductible are

$$EM(m_{j-1}, j) = \int_{m_j} max\Big\{0, m_j - b\Big\}\Omega(m_j|m_{j-1}, j) \tag{2.15}$$

Insurers are competitive and risk neutral. Thus, the break-even premium in the individual market can be written as

$$p(q_j, \mathcal{I}) = \gamma EM(m_{j-1}, j) q_j + \eta \tag{2.16}$$

where γ is the administrative load, which pays the cost of administering the health insurance plan, and η is a fixed cost of underwriting.

The ESHI group market creates a single pool for all enrollees. Since the coverage rate of group insurance is exogenous, subject to the same zero profit condition, premiums in the group market can be written as

$$p_g = \frac{\gamma q_g \Big(\int \mathbf{1}_{\{q_j = q_g\}} EM(m_{j-1}, j) d\Gamma(x) \Big)}{\int \mathbf{1}_{\{q_j = q_g\}} d\Gamma(x))} \tag{2.17}$$

where the numerator is total expected medical expenses above the deductible of the ESHI group insurance participants and the denominator is total number of ESHI group participants. Due to that absence of individual underwriting in the group market the premium does not include a fixed cost of underwriting.

Post-ACA Premium Pricing

In the post-ACA environment, insurers are no longer able to condition premiums in the individual market on medical history. I assume the pricing of the ESHI group premium remains unchanged. Per law, premiums in the post-ACA individual market can only be conditioned on age, j. Thus, $\mathcal{I} = (j, \mathbf{1}_{q_j \in IND})$, where $\mathbf{1}_{q_j \in IND}$ is an indicator variable for choosing any plan offered in the individual market.

Given the Markov chain specification for the evolution of medical expenditure shocks, $\Omega(m_j|m_{j-1}, j)$, with asymmetric information the problem of the insurer is to try to infer the value of m_{j-1} given the information set, $\mathcal{I}$. Let the decision rule for the coverage rate be defined as $q_j = f_q(j, e, s_j, z_{j,e,m_{j-1}}, m_{j-1}, g_j, \kappa_{j,e})$. Let $S(m_{j-1}|\mathcal{I})$ be the set of values for $(e, s_j, z_{j,e,m_{j-1}}, g_j, \kappa_{j,e})$ that for a household with given m_{j-1} are consistent with $\mathcal{I}$ and the decision rule, $f_q(n)$. Let $Pr(m_{j-1}|\mathcal{I})$ denote the probability of an individual having current state m_{j-1} conditional on the observable information and knowledge of the household's decision rule $q_j = f_q(n)$. In a stationary equilibrium, the conditional probability of a household having m_{j-1} can be written as

$$Pr(m_{j-1}|\mathcal{I}) = \int_{S(m_{j-1}|\mathcal{I})} d\Gamma(j, e, s_j, z_{j,e,m_{j-1}}, m_{j-1}, g_j, \kappa_{j,e}) \tag{2.18}$$

With this conditional probability the insurer computes expected medical expenditures above the deductible as

$$EM(\mathcal{I}) = \int_{m_{j-1}} \left[\int_{m_j} max\Big\{0, m_j - b\Big\} \Omega(m_j | m_{j-1}, j) \right] Pr(m_{j-1} | \mathcal{I}) \tag{2.19}$$

The break even premium in the individual market can be written as

$$p(q_j, \mathcal{I}) = \gamma EM(j) q_j + \eta \tag{2.20}$$

2.2.5 The Hospitals

In the model, hospitals do not play any role in the production of medical goods or services. Instead the hospital serves a transfer mechanism. The hospital marks up the out-of-pocket medical expenses of households, $O(m_j, q_j)$ in order to cover the losses it suffers from the unpaid medical bills of defaulters. Insurers always pay their share of the medical bill. The size of the markup, h, charged by hospitals is such that the hospital breaks even. The hospital collects revenue from the markup on paid bills and the positive savings discharged in bankruptcy. The hospital's cost are the unmarked up medical bills that are discharged. The budget constraint of the hospital is

$$\begin{aligned} \int_{n \in N, j < j^*} hO(m_j, q_j) \mathbf{1}_{d_j=0} + \int_{n \in N, j \geq j^*} hm_j (1 - q_{mcr}) \mathbf{1}_{d_j=0} + \int_{n \in N} d_j s_j \mathbf{1}_{s_j > 0} = \\ \int_{n \in N, j < j^*} O(m_j, q_j) \mathbf{1}_{d_j=1} + \int_{n \in N, j \geq j^*} m_j (1 - q_{mcr}) \mathbf{1}_{d_j=1} \end{aligned} \tag{2.21}$$

In equilibrium, the hospitals chooses a markup h such that the above equation holds. Accounting for the payment of unpaid medical bills via an agent, here called the hospital, is important because it creates another channel through which the insurance reform will act. If the ACA successfully lowers the bankruptcy rate, then the markup will decline, and in turn the out-of-pocket medical expenditures of households will fall, raising welfare. Part of the motivation for passing the ACA was to reduce the degree to which the unpaid medical bills of the uninsured are spread across the medical bills of the insured.[2] Uncompensated care, as it is referred to in the hospital industry, is substantial. According to the American Hospital Association, uncompensated care accounts for about 6% of all outlays between 2000 and 2010.[3]

2.2.6 Production Sector

Output is produced by two competitive firms, one of which offers ESHI. Capital is freely allocated across the two firms. Given this set up, production can be described by a single representative firm. Production occurs according to a constant returns to scale, Cobb-Douglas production function, $Y = AK^{\alpha}L^{1-\alpha}$. A is total factor productivity, K is aggregate capital, and L is aggregate effective labor. The firms' profit maximization problem can be written as

$$\underset{K,L}{max} Y - wL - rK \tag{2.22}$$

where r is the rental rate and w is wage per effective unit of labor. Solving the maximization problem yields the equilibrium prices,

$$w = (1-\alpha)AK^{\alpha}L^{-\alpha} \tag{2.23}$$

$$r = \alpha AK^{\alpha-1}L^{1-\alpha} \tag{2.24}$$

The labor market clearing condition is

$$L = \int_{j<j^*} z_{j,e,m_{j-1}} l_j d\Gamma(x) \tag{2.25}$$

and the capital market clearing condition is given by (2.14).

For the firm that does not offer ESHI, $\widetilde{w} = w$. That is, workers are paid their marginal product of labor. Following Jeske and Kitao (2009), in order for the ESHI offering firm to finance its share of the group premium, μ, it subtracts an amount c_E from the marginal product per effective unit, $\widetilde{w} = w - c_E$. The zero profit condition

[2] https://aspe.hhs.gov/pdf-report/insurance-expansion-hospital-uncompensated-care-and-affordable-care-actandhttp://obamacarefacts.com/obamacare-control-costs/

[3] http://www.aha.org/content/16/uncompensatedcarefactsheet.pdf

on firms gives the contribution as

$$c_E = \frac{\mu p_g \int \mathbf{1}_{\{g_j=1 \text{ and } q_j=q_g\}} d\Gamma(x)}{\int l_j z_{j,e,m_{j-1}} \mathbf{1}_{\{g_j=1\}} d\Gamma(x)} \tag{2.26}$$

where the numerator is the total contributions paid by the ESHI offering firm and the denominator is the total effective labor working in the ESHI offering firm.

2.2.7 Government

Prior to the ACA the role of the government is to operate the Social Security, Medicare, Medicaid, and social assistance programs via revenues from the income, payroll, and consumption taxes. Tax revenues and outlays for the various transfer programs can be summarized by

$$\begin{aligned}
Revenues &= \int_x Tax(x) + \tau_c c_j d\Gamma(x) \\
Medicare &= \int_x (q_{mcr} m_j - p_{mcr}) d\Gamma(x|j \geq j^*) \\
Medicaid &= \int_x q_{mcd} m_j d\Gamma(x|y_j < y_{mcd}) \\
Social\ Security &= \int_x ss_e d\Gamma(x|j \geq j^*) \\
Social\ Assistance &= \int_x T_{SI} d\Gamma(x)
\end{aligned} \tag{2.27}$$

I assume the government cannot borrow, so its intratemporal budget constraint is

$$Revenues = G + Social\ Security + Medicare + Medicaid + Social\ Assistance \tag{2.28}$$

where G is exogenous government spending, which does not directly enter the household's utility function.

2.2.8 Other Model Changes Due to ACA

While in the pre-ACA setting individuals can purchase any level of coverage they prefer, i.e. $q_j \in (0, 1]$, per the law plans offered on the age-adjusted community rated exchanges must cover at least 60% of medical expenses on average. The choice set for coverage level is now restricted to $q_j \in [0.6, 1]$.

Post-ACA, those who go uninsured must pay a penalty, $Pen(y_j)$, equal to 2.5% of income or \$695, whichever is larger. Households are exempt from the penalty if the Bronze premium exceeds 8% of their income. For individuals whose premium may be financially burdensome, the ACA stipulates the provision of a subsidy, conditional on income. The premium subsidy is provided no matter what plan is chosen. The size of the subsidy is endogenous to the Silver premium. The premium subsidy ensures that the Silver premium does not exceed a certain share of income, where the share decreases as income gets further from the federal poverty line (FPL). The premium subsidy scheme is summarized in Table (2.1).

Table 2.1: Premium Subsidies in Post-ACA Individual Market

Income (as % of FPL)	**Silver Premium Maximum as % of Income**
<133%	2%
133%-150%	3%-4%
150%-200%	4%-6.3%
200%-250%	6.3%-8.05%
250%-300%	8.05%-9.5%
300%-400%	9.5%

In addition to the premium subsidy, the ACA also offers a cost sharing subsidy, but only to households who select a Silver plan and have sufficiently low income. The cost sharing subsidy raises the coverage rate of the Silver plan from 70% to a higher level. The additional share of the medical expenditure is paid for by the government and does not affect premium pricing directly. Premium pricing is affected to the degree that the subsidy encourages lower income households to participate in the individual market. The provision of the cost sharing subsidy is summarized in Table (2.2).

With these additional changes the budget constraint of the working age household becomes

$$\begin{aligned}(1-d_j)s_j + \widetilde{w}z_{j,e,m_{j-1}}l_j + T_{SI} + B_e + Sub(y_j, m_j) \geq \\ s_{j+1} + (1+\tau_c)c_j + (1-d_j)O(m_j, q_j) + Tax + p + \Delta d_j + Pen(y_j)\end{aligned} \tag{2.29}$$

Table 2.2: Cost Sharing Subsidies in Post-ACA Individual Market

Income (as % of FPL)	Silver Coverage Rate
<150%	94%
150%-200%	87%
200%-250%	73%
>250%	70%

where $Sub(y_j, m_j)$ is the combined amount of premium and cost sharing subsidies.

After the implementation of the ACA, the government earns a new source of revenues through the penalties on the uninsured and faces new outlays, in the form of the subsidies and additional Medicaid transfers. Medicaid eligibility is increased up to 133% of the FPL. Post-ACA, the government's revenues increase by $\int_x Pen(y_j)d\Gamma(n)$ and outlays increase by $\int_x Sub(y_j, m_j)d\Gamma(n)$ and some amount for Medicaid. The ACA also entails the creation of a new 39.6% marginal tax bracket for income above \$450,000 (2013\$). More details on the progressive income tax code can be found in the calibration section.

2.2.9 Competitive Equilibrium

The description of the stationary competitive equilibrium is as follows. Given the parameters that define social assistance, Medicare, Medicaid, and Social Security, $\{\underline{c}, y_{\underline{c}}, q_{mcd}, y_{mcd}, p_{mcr}, q_{mcr}, \overline{y}_{ss}\}$, the coverage rate for ESHI group insurance, q_g, a deduction from ESHI labor's wage, c_E, and the ESHI offering firm's share of the group premium, μ, the competitive equilibrium for this economy consists of time invariant prices $\{w, r, p_g, h\}$ and price function $p(q_j, \mathcal{I})$, decision rules $\{l_j(n), q_j(n), d_j(n), c_j(n), s_{j+1}(n)\}$, and tax functions $\{T(y_j), \tau_y, \tau_c, \tau_{ss}, \tau_{mcr}\}$ such that the following conditions are satisfied:

1. Given the set of time invariant prices and tax rates, the decision rules of the household solve the optimization problems, equations (2.4) and (2.8).

2. The hopsital markup on out-of-pocket medical expense, h, satisfies the hospital's budget constraint, equation (2.21).

3. The wage, w, and the rental rate, r, satisfy the firm's maximization problem, equation (2.22), and the capital and labor markets clear, equation (2.25).

4. The loan pricing locus $x_i(s_{j+1}, \mathcal{I})$ maximizes the present discounted value of cash flows for the financial intermediary, equation (2.14), and satisfies the household's decision rule for assets, $s_{j+1}(n)$.

5. The deduction from wages of the ESHI group, c_E, satisfies equation (2.26) and the ESHI offering firm earns zero profits.

6. The group premium, p_g, satisfies equation (2.17) and the individual premium, $p(q_j, \mathcal{I})$, satisfy equations (2.16) and (2.20) such that insurers earn zero profits.

7. The tax functions $\{T(y_j), \tau_y, \tau_c, \tau_{ss}, \tau_{mcr}\}$ balance the government's intratemporal budget constraint.

8. By Walras' Law the goods market clears.

For the computational procedure used to solve the pre- and post-ACA model, see the appendix of LaCerda (2016).

2.3 Data and Calibration

2.3.1 Data Source

The model is calibrated to match several chosen moments of the debt, insurance, and labor market. In order to estimate the moments of the labor and insurance markets I utilize the Medical Expenditure and Panel Survey (MEPS) from the Department of Health and Human Services' Agency for Healthcare Research and Quality. For the debt market I draw on data from the 2007 Survey of Consumer Finances, the Consumer Bankruptcy Project 2008, and the American Hospital Association.

2.3.2 Calibration

Debt and Default

Compared to the health insurance model of LaCerda (2016), this model introduces nine new parameters related to the debt market. Six of the parameters are the values for the non-pecuniary cost of default, $\kappa_{e,j}$. The cost can take two values for each of the three educational groups. The calibration is summarized in Table (2.1). ρ_κ is the persistence parameter governing the AR(1) process that controls the transition probability across the two values of $\kappa_{e,j}$ for each educational group. In addition, there is a pecuniary cost of bankruptcy, Δ and a proportional transaction cost of borrowing, ω.

Table 2.1: Calibrated Parameters

Parameter	**Definition**	**Value**
ρ_κ	Persistence on AR(1) proccess for κ	0.96
κ^{lo}_{NHS}	Low κ for No High School	0.3
κ^{hi}_{NHS}	High κ for No High School	0.7
κ^{lo}_{HS}	Low κ for High School	0.4
κ^{lo}_{HS}	High κ for High School	0.85
κ^{lo}_{COLL}	Low κ for College	0.4
κ^{lo}_{COLL}	High κ for College	0.95

The value for the pecuniary cost of defaulting is taken from the Consumer Bankruptcy Project data. The data source provides information on preparation, attorney, and filing fees. All together, declaring bankruptcy costs about \$1,500, or in model units, $\Delta = .03$. A review of the literature on the credit card industry suggests that the proportional transaction cost for borrowing, ω, is about 3%, see Evans and Schmalensee (1999).

Taking the previous parameters from the data leaves seven free parameters, the six $\kappa_{j,e}$'s and ρ_κ, to match the desired moments from the data on debt and default. The moments I decided to match are (1) the default/bankruptcy rate of each educational group, (2) the fraction of households with negative net worth, (3) the aggregate negative net worth to GDP ratio, (4) the average amount of negative net worth discharged in bankruptcy, (5) the average borrowing rate chosen by households, and (6) the hospital markup for uncompensated care. The model's performance in matching these moments is highlighted in the next section on baseline performance.

Preferences and Production

The depreciation rate of capital, δ, is set to 5.0%. α is capital's share of income, which is set to 0.33 consistent with U.S. data. Consumption's share of utility relative to leisure, χ, is set to 0.6. The parameter governing the intertemporal elasticity of substitution, σ, is set to 3.0 which yields a constant relative risk aversion of 2.2.[4] Total factor productivity, A, is chosen to normalize aggregate output to one in the pre-ACA setting. The discount factor, β, is chosen to target an aggregate capital to output ratio, K/Y, of 2.95, which yields a discount factor of 0.995.

Demographics

Households begin their lives at age 25. They have 40 years to potentially work then retirement is exogenously enforced at age 65, j^*. A time period in the model is equivalent to one year. The maximum lifetime of a household is limited to 99 years. To calibrate these survival probabilities, $\psi_{j,m_{j-1}}$, I use a method similar to

[4] CRRA$=1-\chi(1-\sigma)$, the calibrated value of 2.2 is consistent with the findings of Mankiw (1985) which finds estimates ranging from 1.8 to 5.3.

Attansio et al. (2011) and Pashchenko and Porapakkarm (2012) and the MEPS data. Individuals in my model are endowed with education, $e \in \{0, 1, 2\}$, at the start of their lives. $e = 0$ signifies less than a high school degree (16% of sample), $e = 1$ signifies a high school degree or GED equivalent (53% of sample), and $e = 2$ signifies a college, technical, or graduate degree (31% of sample). The education shares are taken form the MEPS data.

Insurance

The MEPS records insurance status on a monthly basis. To convert this data to the model's annual basis, I sum up the total number of months that the household reported having each type of insurance and if they have the same type of health insurance for six months or more, they are assigned to that category. Otherwise the household is assigned as uninsured.

The administrative loads on insurance are taken from data by the Congressional Budget Office (CBO). The average administrative load of the group market is 12% and the individual market is 25%.[5] I use the fixed cost of underwriting to target the share of working age population enrolled in the individual market, which produces a value of $\eta = \$241$. By law, in the post-ACA setting I set the administrative load of the individual market equal to the group, $\gamma = 1.12$.

I match the aggregate share of working age households with ESHI by adjusting the share of the ESHI premium covered by the employer, μ. The resulting figure $\mu = 82\%$ is consistent with the average employer contribution of 81% found in previous surveys (Kaiser Family Foundation, 2009). The exogenous coverage rate in the group market, q_g, is set to 80%, the average of the MEPS data. I set the deductible, b, equal to \$1000, which is the average level recorded in Kaiser Family Foundation survey. In the post-ACA setting I adjust the deductible according to the plan level based on data from HealthPocket.[6] The deductibles become \$5,000 for a Bronze plan, \$2,900 for Silver, \$1,300 for Gold, and \$350 for Platinum. Earlier data suggests that although

[5] Congressional Budget Office, Dec. 2008, Key Issues In Analyzing Health Insurance Proposals, https://www.cbo.gov/sites/default/files/cbofiles/ftpdocs/99xx/doc9924/12-18-keyissues.pdf

[6] https://www.healthpocket.com/healthcare-research/infostat/2016-obamacare-premiums-deductibles#.VwKY-RMrJZo

the premiums for the ACA created plans are low, the out-of-pocket costs remain high for households.

The choice set for coverage rates in the individual market is discrete and separated by 10% intervals. In the pre-ACA setting the choice set for coverage rates above the deductible is $q_j \in \{10\%, 20\%, ..., 90\%, 100\%\}$. As stipulated by the ACA, the choice set in the post-ACA environment is $q_j \in \{60\%, 70\%, 80\%, 90\%\}$. $q_j = 60\%$ corresponds to a Bronze plan, $q_j = 70\%$ to Silver, $q_j = 80\%$ to Gold, and $q_j = 90\%$ to Platinum.

Medical Expenditures

For the calibration of medical expenditures, I follow the method of Pashchenko and Porapakkarm (2012) and LaCerda (2016). I begin by separating the dataset into 13 age groups each with a five year span. Within each age group I calculate the percentiles for the medical expenditures. I create five bins for each age group corresponding to the (0-30th), (30th-60th), (60th-90th), (90th-99th), and (99th-100th) percentiles of total medical expenses, which are named Med=1, Med=2, Med=3, Med=4, and Med=5, respectively. In each bin I calculate the average of medical expenditures and assign that value to average age of the group. I use a spline to fill in the missing ages. I create a binary indicator, $\overline{m}$, for whether the medical shock the 90th percentile of medical expenditures for each age. Thus, $m_j \in \{1, 2, 3\}$ corresponds to low medical shocks and $m_j \in \{4, 5\}$ corresponds to high medical shocks.

To determine the transition probabilities of the Markov process, I repeat the procedure above for each of the two years in the MEPS' longitudinal waves. The transition probability between medical expense bins is equal to the share of households that make said move from one year to the next. I calculate the transition probability matrices for working age (25-64) and retired households (65+) separately. Their values can be found in the appendix.

Labor Income

Productivity is given by $z_{j,e,m_{j-1}}$, which is the log sum of a deterministic term, $\lambda_{j,e,m_{j-1}}$, and two shocks. One shock, v_j, is a persistent AR(1) process while the other, ζ_j, is white noise. ρ_z, the parameter controlling the persistence of the AR(1) process, is set to 0.98 and the variance of its innovations, σ_z^2, is set to 0.018, based on Storesletten et al (2004), Hubbard et al (1994), Erosa et al (2011), and French (2005). To construct the initial AR(1) shock, υ_1, I follow Heathcote et al. (2010), and draw the shock from a $N(0, 0.124)$ distribution. I set the variance of the white noise process, σ_ζ^2, to 0.1, following Erosa et al. (2011).

To calibrate the deterministic term, $\lambda_{j,e,m_{j-1}}$, which determines the mean of income at each age, I employ the method of French (2005). I guess and update λ in successive iterations to match the observed labor income profile. For a full description see LaCerda (2016).

Employment

The labor choice set of the working age household is $l_j \in \{0, 0.2, 0.4\}$. From the MEPS, I define a part-time worker as an agent who worked on average at least 10 to 30 hours per week and made at least the federal minimum wage of \$5.15/hour, i.e. \$2,678/year. I define a full-time worker as an agent who worked on average at least 30 hours per week and made at least federal minimum wage, i.e. \$8,034/year.

I match the employment rates by age group, education, and the binary indicator for medical expenditure shock by adjusting the fixed cost to leisure, ϕ_{j,e,m_j}. The fixed cost to leisure is given by $\phi_{j,e,m_j} = \phi_1(e) + \mathbf{1}_{\{m_j > \overline{m}\}}\phi_2(j, e)$. A summary of the calibration of the fixed cost to leisure parameter can be found in Table (2.2).

Table 2.2: Calibration of Fixed Cost to Leisure

Education	$\boldsymbol{\phi_1(e)}$	$\boldsymbol{\phi_2(25, e)}$	$\boldsymbol{\phi_2(64, e)}$
Less than High School	0.3100	0.0600	0.1975
High School or GED	0.2400	0.0400	0.1450
College or more	0.1800	0.0000	0.1675

ESHI Offer

For the calibration of the exogenous ESHI offer I follow Pashchenko and Porapakkarm (2012) and LaCerda (2016) and assume the likelihood of getting an offer is given by a logistic function of the form:

$$Pr(g_j = 1) = \frac{exp(\omega_j)}{1 + exp(\omega_j)} \tag{2.30}$$

where ω_j is an odds ratio determined by the following linear regression:

$$\omega_j = \beta_0^e + \beta_1^e log(inc_j) + \beta_2^e log(inc_j)^2 + \beta_3^e log(inc_j)^3 + \beta_4^e \mathbf{1}_{\{g_{j-1}\}} + \Theta^e D_j \tag{2.31}$$

inc_j is labor income at age j, normalized by the average labor income across all ages, and D_j is a set of year dummies that capture time and trend effects. The preceding regression is run separately for each education group.

Government and Public Insurance

All households are subject to a progressive tax, $T(y_j)$, on all income. The structure of the progressive income tax is taken from the 2008 federal income tax code and is summarized in Table (2.3). Consistent with the federal tax code I allow a deduction of \$9,000 from taxable income to account for the standard deduction of \$8,000 in 2008 and \$1,000 for personal deductions.

Table 2.3: Progressive Income Tax Brackets in 2008 (2008\$)

Marginal Tax Rate	**Income Bracket (\$)**
10%	0 - 11,450
15%	11,450 - 43,650
25%	43,650 - 112,650
28%	112,650 - 182,400
33%	182,400 - 357,700
35%	357,700+
39.6% (Post-ACA only)	435,000+ (2013\$)

Per law, the government charges Social Security, τ_{ss}, and Medicare, τ_{mcr}, payroll taxes of 12.4% and 2.9%, respectively, with the Social Security tax only applying to the first \$102,000 of income, $\overline{y}_{ss}$. The consumption tax, τ_c, equals to 5.67% to match the consumption tax's revenue as a share of total tax revenue in the NIPA data. In order to balance the government's intratemporal budget constraint, I adjust the proportional income tax rate, τ_y. In the pre-ACA setting, the equilibrium proportional income tax rate is 9.6%.

For the Social Security Transfer, I average annual income of each education group from ages 30 to 64, $AIME_e$. The social security payments to retired persons are a fraction of the $AIME_e$, given by

$$ss_e = repl_e * AIME_e \tag{2.32}$$

where $repl_e$ is the replacement rate. According to a Social Security Administration report, the average replacement rates of each education group are 50% for less than high school, 35% for high school or equivalent, and 25% for college and above.[7]

From the MEPS data, the average coverage rate for Medicaid is 82.7% and is skewed right. For this reason, the coverage rate for Medicaid, q_{mcd}, is set to 90%. Per law Medicaid has no premium. Medicaid eligibility is set at 50% of the Federal Poverty Line to match its enrollment share of the working age population. The Federal Poverty Line for a head of household in 2008 is \$10,400. Based on the average in the MEPS data, the coverage rate for Medicare, q_{mcr}, is 70%. By law, the Medicare premium, p_{mcr} in 2008 is \$1,014.

Exogenous government expenditures, G, are set to 19.5% of GDP, based on average spending levels recorded in the BEA's NIPA tables for the years 2000 to 2010. The social assistance program operated by the government, T_{SI}, provides $\underline{c} = \$3,500$ based on the estimates of De Nardi et al. (2010).

[7]The replacement rates are from the U.S. Social Security Administration, Office of the Chief Actuary, `https://www.ssa.gov/OACT/NOTES/ran9/an2014-9.pdf`

2.4 Pre-ACA Baseline Model Performance

2.4.1 Borrowing and Default Statistics

For targeting the chosen moments from the debt and default data I have seven free parameters, six values of the non-pecuniary cost of default, $\kappa_{j,e}$, two for each of the three educational groups, and the persistence, ρ_κ, of the AR(1) process governing the transition probability of κ. As mentioned previously, the moments I aim to match are (1) the default/bankruptcy rates of each educational group, (2) the fraction of households with negative net worth, (3) the aggregate negative net worth to GDP ratio, (4) the average amount of negative net worth discharged in bankruptcy, (5) the average borrowing rate chosen by households, and (6) the hospital markup for uncompensated care. I use ρ_κ to pin down the the aggregate negative net worth to GDP ratio. Problematically, the values of κ are only sufficient to target the default rates for each of the education groups and, consequently, the remaining moments are freely determined by the model. Experimentation with a variety of parameter values reveals that the variance between the two levels of κ is what largely controls the default rate while their level affects aggregate borrowing only slightly.

The data on default rates were calculated from the Survey of Consumer Finances 2007. The survey asks if respondents declared bankruptcy in the last five years. The numbers shown in the table are annualized. Providing a perfect match to the data is complicated by the fact that many households never pay their medical bills without ever formally declaring bankruptcy. The hospitals sell this debt to collection agencies or write them off as bad debt/charity. The literature provides several estimates of the fraction of households with negative net worth. On the low end, Chaterjee et al. (2007) estimates this value as 6.7% and, on the high end, Wolff (2006) estimates it to be 17.6%. I follow Athreya, Tam, and Young (2012) and split the difference at 12.5%. In the model net worth is defined as savings/debt minus out-of-pocket medical expenses.

To determine the ratio of average amount of debt discharged in bankruptcy to average income I utilize the data from the Consumer Bankruptcy Project (CBP) and the BEA's NIPA tables. In the CBP data I average the amount of unsecured debt since this is the data concept that is closest to the model's definition of debt.

Removing outliers, the average amount of discharged unsecured debt is $32,945 and, from the BEA, average household income in 2008 was $52,029. I estimate the average borrowing rate from the SCF data. Problematically the SCF only asks about the interest rate on the credit card with the highest balance, so we would expect the data to underestimate the average rate, assuming a rational household would utilize the card with the lowest rate first. The data on hospital's markup for uncompensated care is taken from the American Hospital Association (AHA).[8] Table (2.1) provides a summary of the model's performance against the data.

Table 2.1: Model Performance in Matching Aggregate Moments from Data

Target	**Model**	**Data**	**Source**
Default Rate — All Edu	1.00%	0.75%	SCF (2007)
Default Rate — No HS	1.70%	0.64%	SCF (2007)
Default Rate — HS	1.17%	0.95%	SCF (2007)
Default Rate — College	0.35%	0.64%	SCF (2007)
Population Share (Net Worth< 0)	13.2%	12.5%	Athreya, Tam, Young (2012)
Agg. NW(NW<0)/GDP	0.49%	0.67%	Chaterjee et al. (2007)
Mean(Discharge)/Mean(Income)	0.52	0.63	CBP and BEA
Avg. Borrowing Rate	20.6%	14.0%	SCF (2007)
Hospital Markup	10.5%	6.0%	AHA

Considering the limited number of free parameters available for calibration, the model performs well in matching these aggregate measures. The default rate is too high for households with low education and too low for those with the most education. If high income households are defaulting relatively more often than other households for non medical reasons, such as divorce or negative home equity, then the model would be unable to capture those changes, resulting in an under prediction of the default rate. The under borrowing of high income households in the model similarly explains the under prediction of the negative net worth to GDP ratio.

The model does a particularly good job of matching the fraction of households with negative net worth and the discharge to income ratio. The average borrowing rate is overstated in the model, but, in addition to the data concerns discussed above, computing the average interest rate on a credit card is not a straightforward matter.

[8] http://www.aha.org/content/16/uncompensatedcarefactsheet.pdf

A single credit card contract offers different rates depending on whether the loan is for a purchase, cash advance, or balance transfer. Furthermore, credit cards typically also offer cash back and other rewards programs. The hospital markup produced in the model is above that seen in the data, but since the model does not allow partial default on medical bills, this is to be expected. In practice, hospitals negotiate with overdue households or sell the debt to collection agencies and recover a fraction of the amount owed.

2.4.2 Insurance Statistics

Table (2.2) provides a comparison of the aggregate insurance statistics taken from the MEPS dataset and the ones produced by the pre-ACA version of the model. The calibration procedure aims to match the overall insurance market shares, the shares for each education cohort are freely determined. Nevertheless, the baseline model performs well at matching the insurance shares across educational groups, as seen when comparing the last three pairs of columns in the table, particularly for households with a high school education.

Table 2.2: Aggregate Statistics of Data and Baseline (Pre-ACA) Model

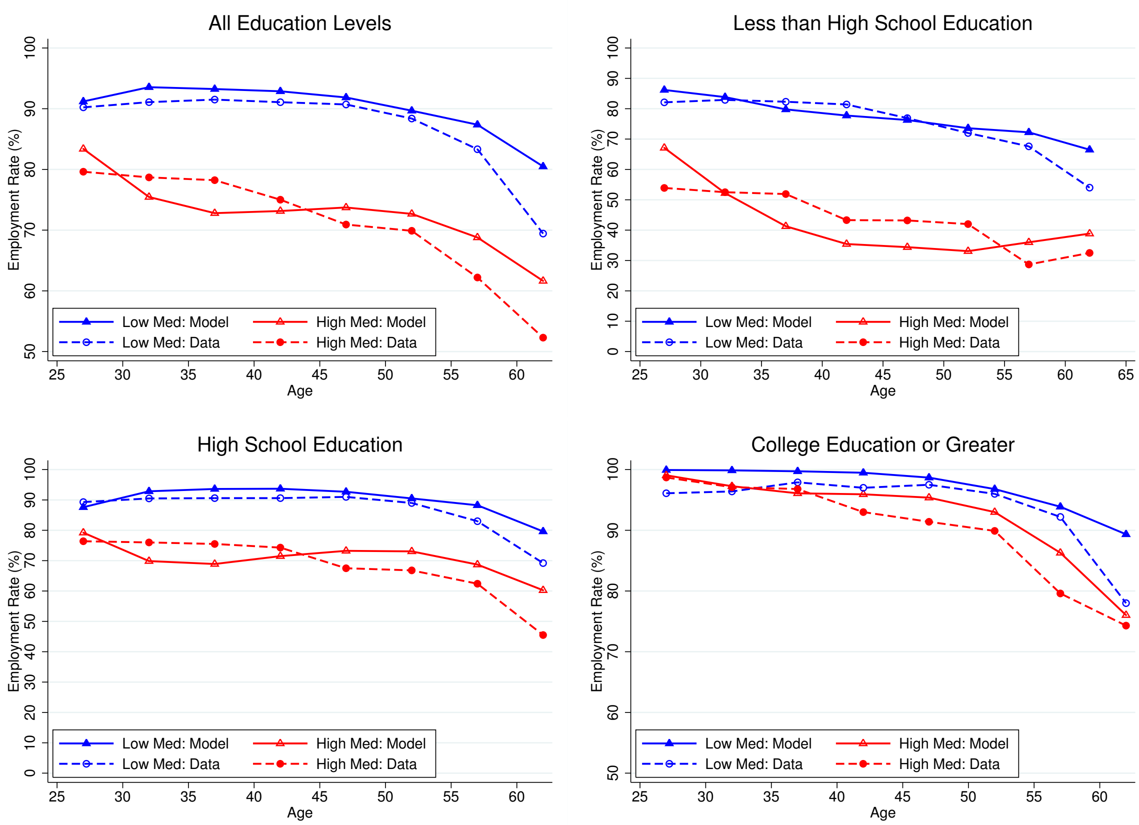
	Total		**Less than HS**		**High School**		**College & Up**	
	Data	Model	Data	Model	Data	Model	Data	Model
Uninsured	22.0	21.4	44.8	30.3	24.0	20.7	9.9	17.8
Medicaid	11.1	11.2	23.3	31.0	12.4	11.1	4.2	0.8
Individual	4.2	5.9	1.7	16.6	3.7	4.6	5.9	2.3
Group	62.7	61.6	30.2	22.2	59.9	63.7	80.1	79.1

The model overstates participation in the individual market for the least educated households. While in the model Medicaid is only available to low income households, in practice Medicaid is also available to households who experience large medical expenditure shocks or become disabled due to illness or accident. The availability of this "catastrophic coverage" ex-post of a bad medical shock would encourage more households to go uninsured and make them less likely to buy individual insurance, which is what we see in the data. For the same reason, the model under predicts the participation of the most educated in Medicaid. High income households are precluded from Medicaid eligibility in the model, but in practice they can obtain public insurance through categorically eligibility such as a disability.

2.4.3 Employment Statistics

Figure (2.1) presents the employment rates for each educational group by age and the binary indicator for medical shock. Employment and labor force participation are equivalent in the model. The model provides a close match to the observed patterns in labor force participation, however the model over predicts the participation rate of younger households with low medical expenditure risk, as shown in the top left panel. The over prediction is a likely consequence of the absence of parental transfers in the model, which would delay labor force participation amongst younger individuals. The high employment rates observed in the data are a consequence of restricting the sample to the heads of households.

Figure 2.1: Insurance Status by Age, Pre-ACA Model versus Data



2.5 Results

This section analyzes the changes to the economy from the implementation of the ACA. Section 2.5.1 focuses on the changes to various measures of debt and the credit market. Section 2.5.2 discusses the changes to insurance choice. Section 2.5.3 analyzes the general equilibrium and welfare effects of the ACA. All comparisons are between steady states and do not consider the transition period. I primarily focus on the changes to working age households because they are the direct beneficiaries of the ACA.

2.5.1 Borrowing, Net Worth, and Default

In this section I answer the question posed by this research: how does the ACA affect household debt and default? To begin, I analyze the changes to the aggregate measures targeted by the calibration. They are (1) the default/bankruptcy rates of each educational group, (2) the fraction of households with negative net worth, (3) the aggregate negative net worth to GDP ratio, (4) the average amount of negative net worth discharged in bankruptcy, (5) the average borrowing rate chosen by households, and (6) the hospital markup for uncompensated care. Table (2.1) summarizes the changes to these measures in the pre- and post-ACA settings of the model.

Table 2.1: Comparison of Pre- and Post-ACA Models

Target	**Pre-ACA**	**Post-ACA**	**Change**
Default Rate — All Edu	1.00%	0.63%	-0.37%
Default Rate — No HS	1.70%	1.11%	-0.59%
Default Rate — HS	1.17%	0.74%	-0.43%
Default Rate — College	0.35%	0.20%	-0.15%
Population Share (Net Worth< 0)	13.2%	11.1%	-2.1%
Agg. NW(NW<0)/GDP	0.49%	0.57%	+0.08%
Mean(Discharge)/Mean(Income)	0.52	0.49	-0.03
Avg. Borrowing Rate	20.6%	17.4%	-3.2%
Hospital Markup	10.5%	7.3%	-3.2%

The ACA portends a substantial reduction in the number of bankruptcies. The default rate of the total population falls from 1.00% to 0.63%. As a fraction of the total number of bankruptcy fillings, this change is significant. The number of defaulters falls by roughly one-third. With 1,074,225 bankruptcy filings in 2008 (according to the American Bankruptcy Institute), the implementation of the ACA is predicted to reduce the the number of filings by over 300,000 annually.[9] The most substantial change in bankruptcies is experienced by the lowest education cohort, where the default rate falls from 1.70% to 1.11%. The sharp decline is the result of the ACA's Medicaid expansion and subsidies creating new transfer payments from high income households to the poor and previously uninsured. Furthermore, given the survey data evidence that large, unforeseen medical expenses are one of the primary causes of bankruptcy, more insurance should be expected to alleviate medically induced bankruptcy. While more insurance reduces the precautionary savings motive of previously uninsured households, reducing net worth and increasing the probability of bankruptcy, this counter acting effect is less significant than the effect of increased insurance. The default rate of households with a high school education also falls significantly for the same reasons. Notably, the increased participation in insurance markets reduces the incentive to use default as a form of health insurance.

With fewer households defaulting, the lower default probability reduces the average interest rate on borrowing from 20.6% to 17.4%. The decline in interest rates results in an increase in the total amount of borrowing, as evidenced by the increase in the aggregate negative net worth to GDP ratio. Recall, in the model net worth is defined as savings/debt minus out-of-pocket medical expenses. Since the increase in insurance lowers the aggregate amount of out-of-pocket medical expenditures, the increase in the aggregate negative net worth to GDP ratio implies that the increase in borrowing exceeds the reduction in out-of-pocket medical costs.

Despite the increase in aggregate negative net worth, the fraction of the population with negative net worth decreases. Those who borrow are borrowing more, but the overall number of people with negative net worth has decreased. This phenomenon can be partially explained by the decline in the hospital markup necessary to cover uncompensated care, which falls from 10.5% to 7.3%. With fewer households defaulting the total amount of discharged medical bills decreases. The corresponding

[9] http://abi-org.s3.amazonaws.com/Newsroom/Bankruptcy_Statistics/Quarterlynonbusinessfilings1994-Present.pdf

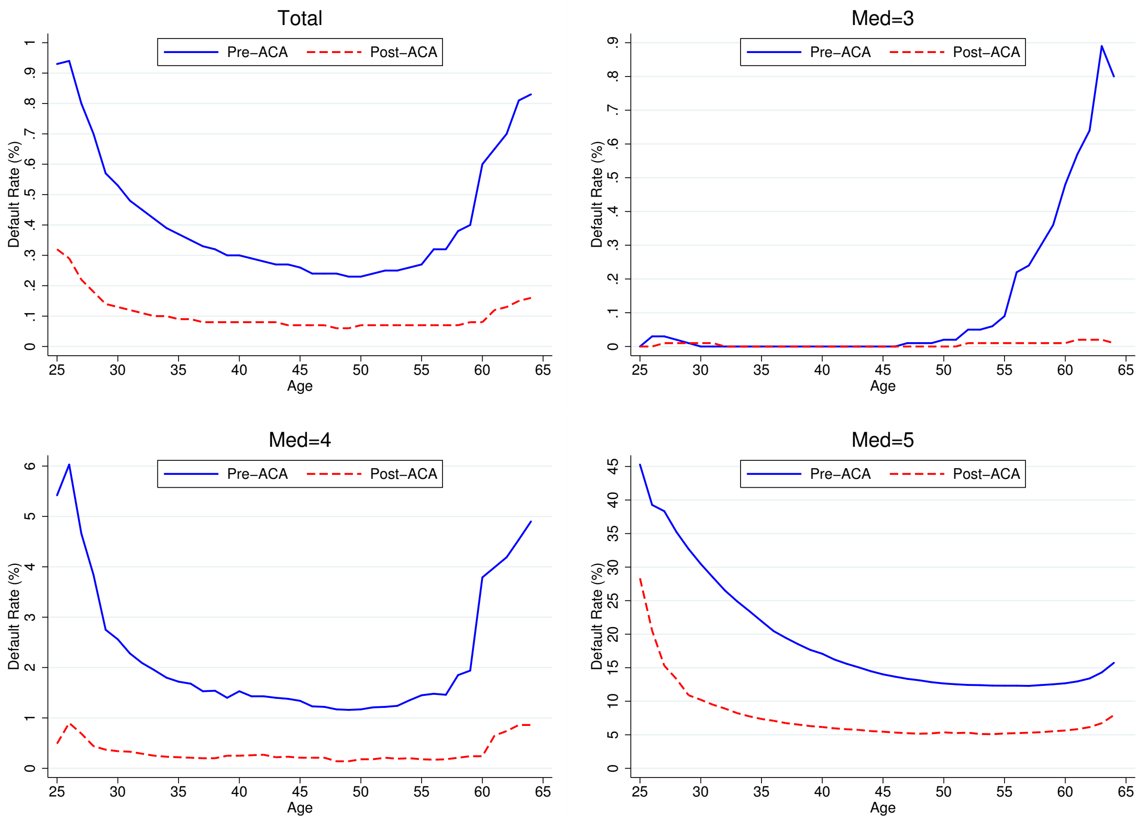
decline in the hospital markup benefits all households through reduced out-of-pocket medical expenses. As out-of-pockets costs fall, the number of people with negative net worth shrinks. The reduction in the number of households with negative net worth suggests that the ACA improves the financial well-being of U.S. households. Whether the ACA improves the medical well-being of U.S. households is left to future research.

Taking a closer look at how the ACA is affecting default rates across households of different ages and medical expenditure risk, Figure (2.1) provides a breakdown of default rates for the overall working age population and the three highest medical expenditure risk cohorts in the pre- and post-ACA settings. The lowest two medical expenditure risk cohorts are not provided because the pre-ACA default rates for these groups are not significantly different from zero.

The top left panel, which shows the default rate by age for the entire working age population, makes clear that default is largely the provenance of the youngest and oldest households. This result is consistent with the findings of Sullivan, Warren, and Westbrook (2000) that the young have very few gross assets which implies that even a relatively small medical expenditure shock can result in negative net worth and a higher likelihood of default. Further evidence is provided by an examination of the default rates of young households across the different size medical expenditure shocks. Young households in the 60^{th} to 90^{th} of medical expenditures, i.e. Med=3 the top right panel, have a pre-ACA default rate near zero. But for higher medical expenditure shocks, the bottom two panels, the pre-ACA default rate is significantly higher at younger ages.

Post-ACA, the default rate of young households falls to zero for nearly all medical risk cohorts, except those in the highest medical risk category. Because the medical shocks of these households are so large, the insurance offered by the ACA, which tends to exhibit high deductibles, provides insufficient coverage to prevent all default. Also, the health insurance contracts in the model do not have out-of-pocket maximums. Including the out-of-pocket maximum, as the law stipulates, may reduce the default rate of households with very large medical shocks, but premium prices would also be higher, resulting in more uninsured and offsetting the drop in defaults from the inclusion of out-of-pocket maximums.

Figure 2.1: Average Default Rate by Medical Shock and Age, Pre-ACA and Post-ACA Models



The increase in pre-ACA default rates after age 50 is a consequence of the rapid increase in the level of medical expenditures beginning at this age. Older households with lower medical expenses, Med=1 and Med=2, (not shown) do not experience the same increase in default at older ages as those in the Med=3 and Med=4 categories. The same pattern does not emerge for older households with the highest possible medical shocks, Med=5. Because these households tend not to work, their low incomes make them eligible for Medicaid, which offers a very high coverage rate. Younger households tend to work more, and their higher incomes preclude their eligibility for Medicaid, resulting in a high default rate at young ages. Post-ACA, the default rates of older households falls across all categories of medical expenditures.

As mentioned before, the ACA's lowering of the default rate results in a decrease in the interest rates offered to households, which is consistent with the finding in Table (2.1) that the average interest rates on loans *chosen* by households falls. Figure (2.2) compares the average pre- and post-ACA discount rates *offered* to households for different size loans. The decline in interest rates, i.e the rise in the discount rates, occurs primarily at low levels of borrowing, as shown in the right hand panel. In terms of interest rates, the change varies from roughly -7% for loans of size 0.1 model units (about $5,000 in 2008) to -1% for smaller sized loans. Lower borrowing costs help reinforce the overall welfare gain of the reform, as discussed in a later section.

Figure 2.2: Average Offered Discount Rate on Loans, Pre-ACA and Post-ACA Models

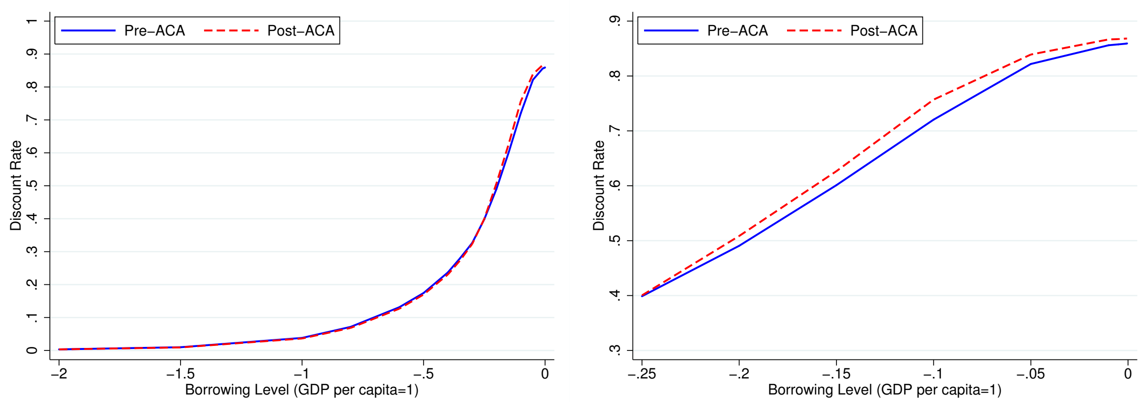
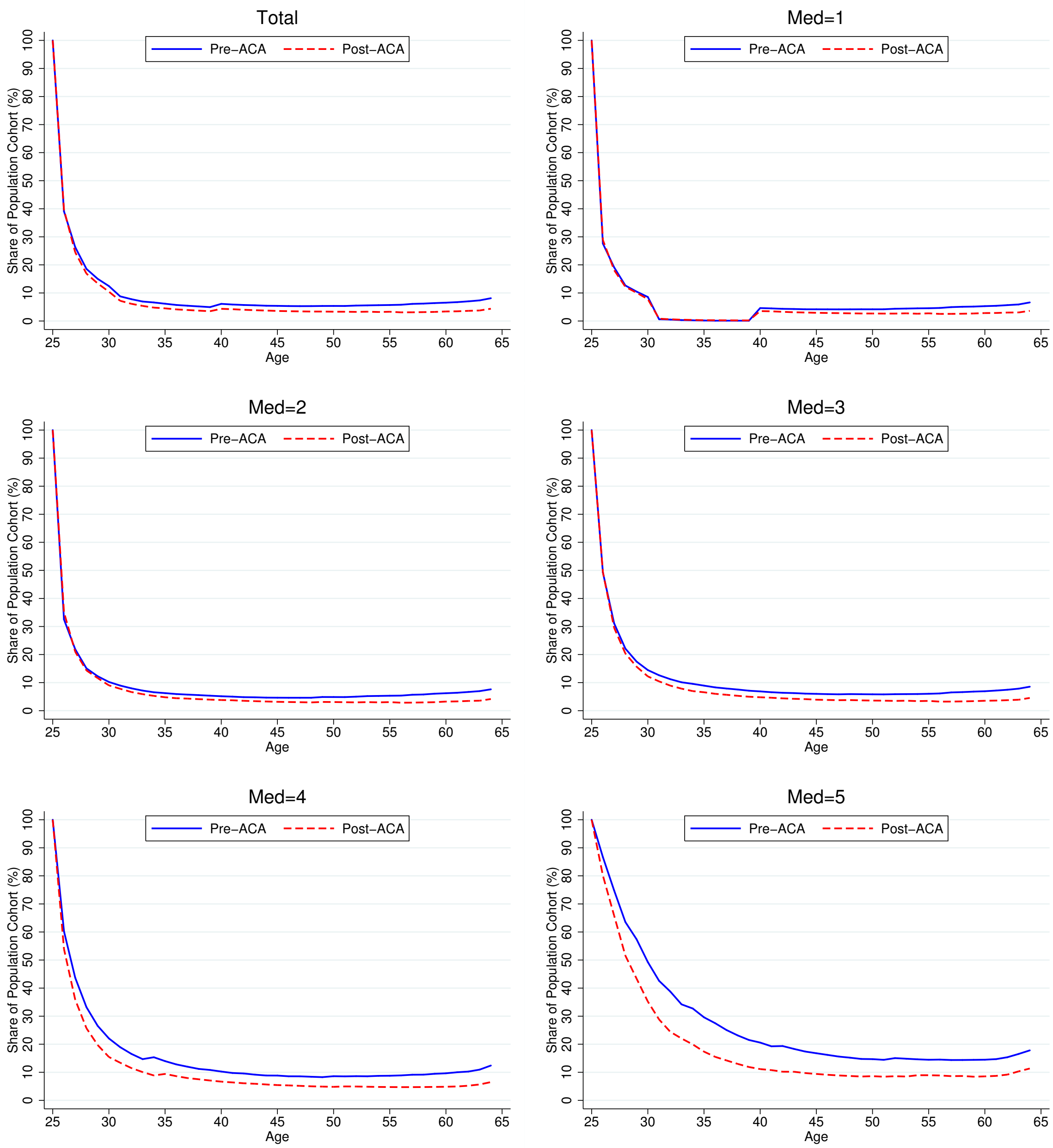


Figure (2.3) shows the fraction of households with negative net worth by age and medical expenditure category for the pre- and post-ACA settings. As mentioned before, younger households are more likely to have negative net worth. In the model, new-born households start their lives with zero assets so any size medical expenditure shock will result in negative net worth. As shown in Figure (2.3), 100% of 25 year olds have negative net worth. As households accumulate assets over their working lives this fraction shrinks rapidly. Comparing the pre- and post-ACA environments, the fraction of households with negative net worth falls across all ages and medical expenditure categories. The largest changes are for households with the highest medical expenditure shocks, Med=5. Absent an ESHI group offer, these households' high risk limit their participation in the pre-ACA individual market because their premiums are relatively high.

With the premium pricing restrictions in the ACA the insured rate of high risk households increases significantly, lowering the fraction with negative net worth. Furthermore, in the post-ACA setting these high risk type households also tend to select the higher coverage Platinum plans, which maximizes the reduction in their out-of-pocket expenses. At ages closer to retirement, the fraction of household with Med=5 and negative net worth falls from about 15% to 10%, a reduction of one-third. The drop in the fraction of households with negative net worth continues through retirement (not shown). While no changes are made to the costs or benefits of the Medicare program, more insurance during working ages prevents large medical expenditure shocks from wiping out households savings. Because of the ACA's effects at working ages, households are entering retirement with more assets.

Figure 2.3: Share of Population with Negative Net Worth by Medical Shock and Age, Pre-ACA and Post-ACA Models



2.5.2 Health Insurance Markets

In this section I analyze how the ACA changes the distribution of insurance coverage. I give specific attention to reinforcing the explanations of the changes discussed in the previous section on debt and borrowing. LaCerda (2016) provides a more complete discussion of the reasoning behind the changes in insurance choice. Table (2.2) presents the changes to the shares of different types of insurance coverage before and after the reform for different education groups.

Table 2.2: Insurance Market Participation: Pre-ACA v. Post-ACA Model

	Total		**Less than HS**		**High School**		**College & Up**	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Uninsured	21.4	2.4	30.3	3.3	20.7	2.2	17.8	2.1
Medicaid	11.1	22.8	31.0	46.6	11.1	24.5	0.8	7.4
Individual	5.9	18.5	16.6	33.1	4.6	16.8	2.3	13.8
Group	61.6	56.3	22.2	16.9	63.7	56.6	79.1	76.8

The primary factor behind the decline in consumer bankruptcy is the significant decrease in the fraction of households that go uninsured. With the carrots of the subsidies and Medicaid expansion and the stick of the penalty, the uninsured rate drops from 21.4% to 2.4% under the ACA. Participation in the individual market expands three-fold, from 5.9% to 18.5% and enrollment in Medicaid doubles from 11.1% to 22.8%. The number of households in the ESHI group market decreases by about 5%, but this change is largely an artifact of older households leaving the ESHI offering firm. By retiring early they lower their income and become eligible for the subsidies, which allows older and riskier individuals to buy insurance in the individual market. A more detailed discussion of this phenomenon is provided in LaCerda (2016).

The changes in the overall shares are largely driven by households without a high school education. Pre-ACA, the high rate of uninsured among the least educated left this cohort more exposed to large medical expenditure shocks. Consistent with the relatively large decline in the default rate for the least educated cohort, the number of uninsured households without a high school education shrinks to a tenth of its pre-ACA size. The increase in the fraction selecting Medicaid is larger in this paper than in LaCerda (2016) because the calibration for eligibility varies slightly between the two models. The directions of the changes for each type of insurance coverage are consistent across educational groups and only vary in their magnitude. High school and college educated households already participated in the ESHI group market at high rates before the ACA and thus the relatively more moderate increases in the shares of Medicaid and the individual market result in a less pronounced decline in their post-ACA default rates.

Taking a closer look within the community-rated individual market, Table (2.3) presents the relative shares of the different coverage levels for each educational group. Contrasting with LaCerda (2016), in this model the premium subsidy is available at all coverage levels and the cost sharing subsidy is provided at the Silver level. As a result, the post-ACA distribution of insurance choice becomes more skewed, with more households selecting the lowest and highest plans, Bronze and Platinum. Less medically risky individuals buy the least amount of insurance possible, Bronze, because the benefit of risk reduction is minimal compared to the additional consumption that becomes possible by paying a lower premium. Riskier households behave in the exact opposite manner and congregate in the highest coverage plan, Platinum. The distribution of coverage is similar across educational levels. Eligibility for the cost sharing subsidy entices more less educated households to select the Silver plan at a higher rate. With higher incomes, more educated individuals select the Platinum plan at a greater rate. While under CRRA preferences, lower income households are motivated to purchase more insurance coverage, the presence of the social assistance program distorts the insurance decision of lower income households.

Table 2.3: Aggregate Individual Market Insurance Share by Plan Level and Education

Education	**Bronze (60%)**	**Silver (70%)**	**Gold (80%)**	**Platinum (90%)**
Less than High School	51.2	23.8	0.4	24.6
High School or GED	56.5	19.9	0.1	23.5
College or more	55.3	15.1	0.2	29.4
Total	54.7	19.9	0.2	25.2

2.5.3 General Equilibrium Effects of ACA

Aggregate Measures

This section summarizes the post-ACA changes to several important economic aggregates. Table (2.4) details the changes to the firm's wage deduction for financing the ESHI group premium as well as the wage, interest rate, and measures of output, savings, taxes, employment, and the distribution of wealth.

Table 2.4: Pre-ACA and Post-ACA Comparison of Selected Aggregate Measures

Variable	**Pre-ACA**	**Post-ACA**
Output per Capita	1.00	0.98
Capital Stock	2.95	2.91
Risk Free Interest Rate (%)	6.20	6.16
Proportional Tax Rate (%)	9.6	11.1
Wealth Gini Coefficient	0.612	0.602
Wage per Effective Unit of Labor (Pre-ACA GDP=1)	1.179	1.182
Employment Rate (%)	89.1	93.4
Wage Deduction for ESHI Premium (Pre-ACA GDP=1)	0.054	0.044

The ACA does not induce substantial changes in most of the aggregate measures. Output, the capital stock, the risk free interest rate, and wage per effective unit of labor do not change significantly. The proportional income tax rate used to balance the government's budget constraint rises 1.5%. The provision of the premium and cost sharing subsidies, as well as the expansion of Medicaid, result in a substantial increase in government outlays. The additional revenue received from the penalties paid by the uninsured are not enough to offset the higher spending, necessitating an increase in taxes. Recall from the previous section, in the post-ACA setting only 2.4% of working age households go uninsured. By redistributing resources from the healthy and high income households to the medically risky and poor, the subsidies and Medicaid expansion reduce the amount of wealth inequality, as evidenced by the decline in the Gini coefficient. Furthermore, by expanding insurance and reducing the default rate, especially, for less educated households, the ACA encourages lower income households to accumulate more assets during their working years.

In contrast to LaCerda (2016), this version of the model predicts that the ACA induces an increase in overall employment. The rise in employment is a consequence of the expansion of Medicaid. Many households forgo working in order to maintain eligibility for public insurance. By raising the income eligibility threshold, fewer households are discouraged from working. This effect more than offsets the decline in employment caused by the early retirement of high risk households. Early retirement reduces the average medical expenditure risk of the ESHI group pool, resulting in a decline in the group market premium and the firm's wage deduction to finance its share of the ESHI premium.

The absence of significant general equilibrium effects resulting from the health insurance reform is desirable. In open economies, such as the U.S., less significant adjustments in the general equilibrium would be expected.

Welfare Changes

Table (2.5) shows the welfare changes by education, income, ESHI status, and medical expenditure risk as measured by consumption equivalent variation (CEV) of the 25-year-old "newborns".[10] A positive amount indicates the percent of pre-ACA consumption a household would give up during the first period of their life in order to be indifferent between living in the pre-ACA and post-ACA economies.

Overall the welfare change is positive with newborns willing to give 2.12% of their first year consumption to live in the post-ACA economy. Households endowed with less than a high school education realize the greatest gains from the reform, with an average CEV of 5.17%. However, this improvement comes at the expense of college educated households, who register a CEV of -1.03%. Compared to the same model of health insurance without borrowing and default, LaCerda (2016), these welfare gains are larger.

There are two likely explanations for the larger welfare gains in this model, both of which relate to the reduction in default. First, by lowering the default rate the ACA also lowers interest rates on loans which makes it less costly for households to smooth

[10] CEV is calculated as $CEV(x) = 100\left[1 - \left(\frac{V^B(x)}{V^R(x)}\right)^{\frac{1}{\chi(1-\sigma)}}\right]$ where $V^B(x)$ is the pre-ACA ex ante value function of a new born (age 25) endowed with state (x) and, similarly, $V^R(x)$ is the post-ACA ex ante value function.

Table 2.5: Consumption Equivalence Variation of the Post-ACA Economy

Overall	**Less than HS (LE)**			**High School (HE)**		**College (XE)**	
2.12	5.17			1.06		-1.03	
	LE			**HE**		**XE**	
υ_j	$\zeta_j = 1$	$\zeta_j = 2$		$\zeta_j = 1$	$\zeta_j = 2$	$\zeta_j = 1$	$\zeta_j = 2$
1	5.26	5.25		1.97	1.97	0.66	0.50
2	5.25	5.34		1.96	1.96	0.60	0.14
3	5.35	5.65		1.78	1.69	0.10	-0.15
4	5.68	5.58		1.45	1.40	-0.75	-0.70
5	5.24	5.08		0.98	1.01	-1.16	-1.14
6	4.49	4.52		0.48	0.53	-1.58	-1.61
7	4.24	4.46		-0.07	-0.07	-2.05	-2.07
8	4.35	4.55		-0.39	-0.39	-2.27	-2.32
9	4.63	4.70		-0.36	-0.62	-2.30	-2.43
	No ESHI Offer			**ESHI Offer**			
LE	5.21			4.98			
HE	1.06			1.06			
XE	-1.04			-1.03			
	Med=1	**Med=2**	**Med=3**	**Med=4**	**Med=5**		
LE	4.87	5.04	5.31	5.93	6.78		
HE	0.95	1.06	1.13	1.19	1.48		
XE	-1.11	-1.02	-0.99	-0.96	-0.89		
All	1.94	2.07	2.20	2.46	2.91		

Labor productivity is the log sum of a persistent AR(1) shock, υ_j, and a white noise shock, ζ_j. The persistent shock is calibrated with nine grid points and the transitory with two. Higher grid points correspond to larger shocks.

their consumption. Second, by reducing default the ACA lowers the markup hospitals must charge to recover the losses they suffer on unpaid medical bills. By reducing the size of out-of-pocket medical bills, the ACA helps relax the budget constraints of households which in turn increases their consumption and utility.

The source of the variation in welfare across different education groups becomes more apparent when viewing the CEVs across income groups. The CEVs decrease as income rises suggesting that the redistributive elements of the ACA, i.e. the subsidies and Medicaid expansion, are driving the welfare gains. Higher income households, who predominantly participate in the ESHI group market, see their premiums fall slightly but this benefit is more than offset by the increase in taxation and the penalty.

The welfare gains are increasing in the size of the medical shock. This result is to be expected given that riskier households put a higher value on insurance. However, even college educated households in the highest medical expenditure risk category still see their welfare decline. Medical expenditure risk is not so persistent. A working age household who has Med=5 faces a 21.3% chance that they will receive another Med=5 shock in the next period. In other words, even though a high productivity household starts their life with high medical expenditure risk, they expect to become lower risk in the near future. Given that they also likely have access to the ESHI group market, they would prefer the economy without the health insurance reform.

2.6 Conclusion

This paper finds that the Patient Protection and Affordable Care Act induces a significant decline in the default rate of households, especially those with less education. Furthermore, the law reduces the number of households who hold negative net worth. By increasing the provision of insurance, the law reduces the degree to which large, medical expenditure shocks lead to bankruptcy. In doing so, interest rates on loans and the markup charged by hospitals to cover uncompensated care are reduced. While much research has focused on how health insurance affects the medical spending and health capital of households, this research suggests that the manner in which the ACA increases access to health insurance, at the very least, improves the financial well-being of U.S. households.

Problematically, this paper stops short of being able to fully characterize the types of health insurance contracts made available through the ACA's new individual marketplace. Most notably, the health insurance contracts in this model lack out-of-pocket maximums. The effect of introducing this feature is not clear since the statutory maximums still represent a substantial fraction of average household income. Furthermore, medical expenditures in the model are exogenous. To the degree that the health insurance raises medical spending, and in turn premiums and prices, we would expect the decline in the number of uninsured and default to be less significant.

While this model treats all borrowing as unsecured debt, future work on bankruptcy and health insurance would benefit from the inclusion of collateralized debt such as mortgages, which are excludable from creditors, and educational loans, which cannot be discharged in bankruptcy.

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A Additional Figures and Tables

Figure A.1: Average Medical Expenses by Age, MEPS 2000-2010

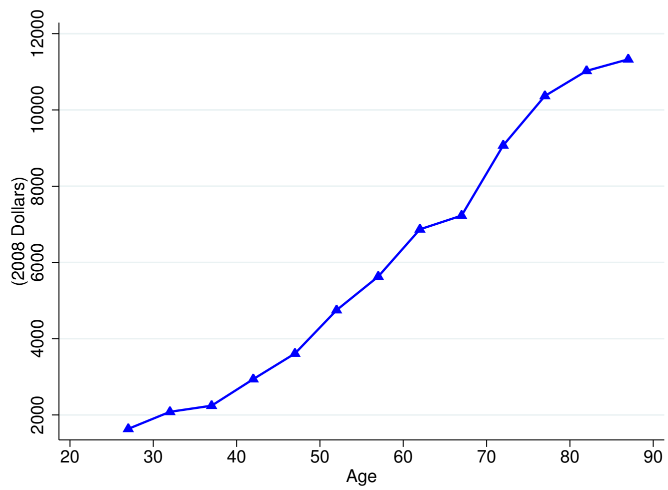

Figure A.2: Medical Expenditure Shocks by Age

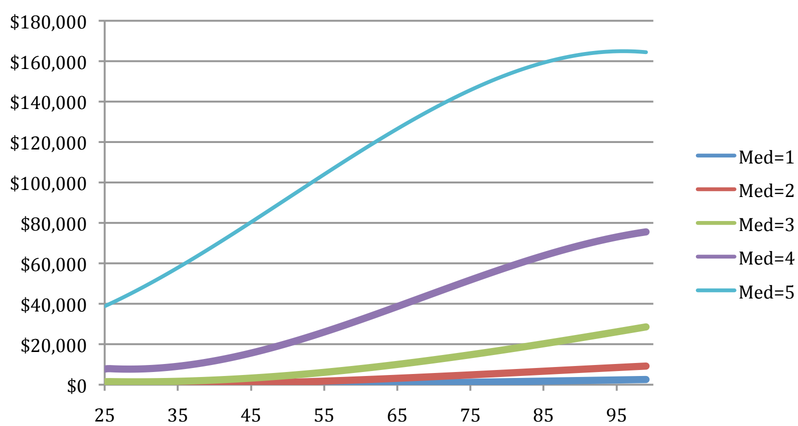

Figure A.3: Medical Expenditure Shocks by Age, Only Med=1,2,3

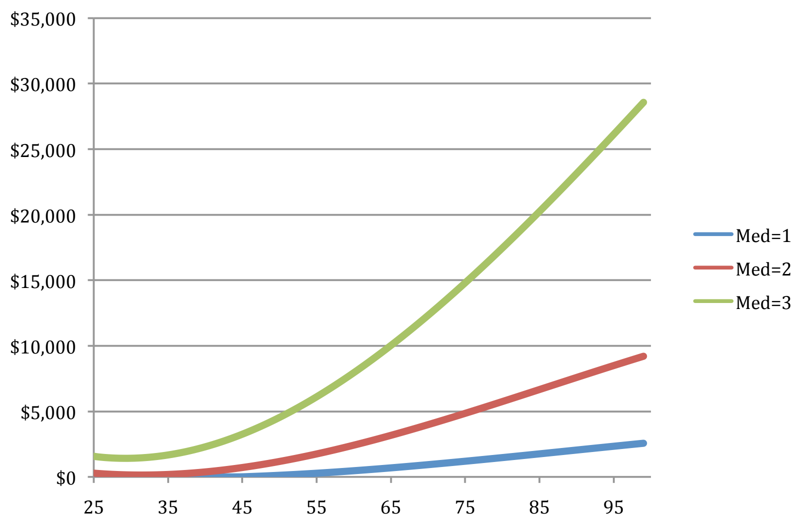

Table A.1: Transition Probabilities Across Medical Expenditure Bins, Working Ages

Year1/Year2	Med=1	Med=2	Med=3	Med=4	Med=5
Med=1	0.637	0.242	0.096	0.022	0.003
Med=2	0.298	0.413	0.239	0.047	0.003
Med=3	0.128	0.298	0.464	0.101	0.008
Med=4	0.084	0.163	0.421	0.302	0.031
Med=5	0.057	0.103	0.248	0.379	0.213

Table A.2: Transition Probabilities Across Medical Expenditure Bins, Retired Ages

Year1/Year2	Med=1	Med=2	Med=3	Med=4	Med=5
Med=1	0.631	0.212	0.121	0.033	0.003
Med=2	0.245	0.420	0.266	0.065	0.004
Med=3	0.121	0.301	0.440	0.128	0.011
Med=4	0.079	0.173	0.457	0.257	0.034
Med=5	0.032	0.135	0.375	0.386	0.072