Essays on health insurance reform

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Essays on Health Insurance Reform

Brian Fischer

A Dissertation Submitted to the
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University at Albany, SUNY

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Dissertation Abstract

Overlapping generations models of general equilibrium are developed to study health insurance reforms in the U.S. The models share common features such as heterogeneity in health, medical expenditures, productivity, and endogenous insurance decisions, and capture key aspects of the U.S. insurance system. Each model is calibrated to match the 2007 U.S. economy.

Chapter 1 studies health insurance reforms in the Patient Protection and Affordable Care Act of 2010 and assesses the impact of the Supreme Court ruling in National Federations of Independent Businesses vs. Sebelius (2012) regarding Medicaid expansion. The reforms reduce the percent uninsured from 22.5% in the baseline model to 6.8% when Medicaid is expanded, and 9.2% when Medicaid is not expanded. Due to exemptions provided in the law, less than 35% of the uninsured are subject to the individual mandate tax. Eliminating the mandate exemptions, community rating for nongroup insurers, or extending subsidies below the poverty level each increase insurance coverage. Expected welfare gains are achieved independent of Medicaid’s expansion.

Chapter 2 studies the effect of the Affordable Care Act reforms, and further reforms to Medicaid on bankruptcy rates. Agents can default on debt obligations through Chapter 7 personal bankruptcy. The reforms reduce the percent uninsured and significantly lower the incidence of medical bankruptcies. More modest reductions in medical bankruptcies occur when Medicaid is not expanded. Cost-sharing subsidies and the individual mandate exemptions help reduce medi-
cal bankruptcies. In addition to the ACA reforms, further reductions in medical bankruptcies can be achieved through increasing Medicaid’s medically needy income eligibility limit to the categorical level.

Chapter 3 studies replacing Medicare with a voucher program modeled after past legislative proposals. Medicaid’s medically needy program reduces incentives for retirees to save and purchase insurance under the reform. With a voucher program, group coverage applies to the full cost of retiree medical care, which increases the firms cost of providing health insurance to retirees. Welfare gains among newborns and agents entering retirement can be achieved if the voucher and Medicaid’s medically needy program are only available to insured retirees, and if a subsidy is included that limits spending on Medicare premiums to 30% of income.
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Chapter 1

Welfare, Insurance Coverage and Medicaid Expansion in a Model of Health Policy Reform

1.1 Introduction

The Patient Protection and Affordable Care Act (ACA) seeks to achieve near universal insurance coverage through a set of reforms including an expansion of the Medicaid program for low income earners, nongroup insurance regulations, cost-sharing subsidies and an individual mandate that taxes the uninsured. A key component of the reform, mandatory Medicaid expansion for non-elderly adults, was ruled unconstitutional by the Supreme Court (National Federation of Independent Business v. Sebelius, 2012). This paper studies the impact of excluding
Medicaid expansion from the reform on insurance coverage rates and welfare.

An overlapping generations general equilibrium model is developed that includes uncertain medical expenditure shocks and endogenous health insurance purchase decisions. The model is calibrated to the U.S. economy using data from the Medical Expenditures and Panel Survey 2000-2010 data set to match key moments and life cycle profiles observed in the data. The model’s health insurance framework is structured to capture many of the key features of the U.S. health insurance system. Workers choose between tax preferred and employer subsidized group insurance if it is offered through the workplace, nongroup insurance where premiums are conditioned on expected medical expenditures or obtaining coverage through Medicaid, which is means tested. Eligibility thresholds for workers depend on demographic characteristics, which reflects the heterogeneity in Medicaid eligibility requirements for non-elderly adults. All retirees are enrolled in the Government’s Medicare health insurance program.

The model predictions in terms of the effect on group insurance markets, reductions in the percent uninsured and the net cost of the reform closely match long run estimates of the Congressional Budget Office (Elmendorf, 2012, 2009). In a baseline model, the ACA reforms reduce the percent uninsured to 6.8% when Medicaid is expanded and 9.2% when it is not. Reductions in the percent uninsured are achieved through increases in nongroup insurance coverage and Medicaid participation, when the program is expanded, and in nongroup insurance coverage alone when Medicaid is not expanded. The reform results in an expected welfare
gain equivalent to 3.3% of consumption when Medicaid is expanded and 1.8% when Medicaid is not expanded.

Cost-sharing subsidies and the individual mandate provide incentives for the uninsured to purchase insurance. However, individuals with incomes below the poverty line are ineligible for cost-sharing subsidies, and exemptions from the mandate tax are provided for individuals with incomes below the tax filing threshold or if the cost of purchasing insurance exceeds 8% of income. As a result, when Medicaid is not expanded only 27% of the uninsured are subject to the mandate tax. Adjustments to the reform are considered as ways of further reducing the percent uninsured. Extending subsidies to those with incomes below the poverty line, removing the mandate tax exemptions, or excluding the community rating provision which restricts nongroup insurers to condition premiums only on age each result in a greater reduction in the percent uninsured compared to the ACA in its current form. Removing the community rating restriction or the mandate exemptions results in greater insurance coverage compared to the reform with Medicaid expansion.

The Supreme Court’s ruling in National Federation of Independent Business v. Sebelius (2012) provided states the choice over whether to expand Medicaid coverage for non-elderly adults. As shown in table 1.1, 25 states plus Washington D.C. representing 53% of the population have chosen to expand Medicaid coverage. The remaining 25 states with 47% of the population have chosen not to expand coverage highlighting the importance of determining how exclusion of

3
Table 1.1: Comparing States by Medicaid Expansion Decisions

<table>
<thead>
<tr>
<th>Medicaid Expansion</th>
<th>Total</th>
<th>Expanding</th>
<th>Not Expanding</th>
</tr>
</thead>
<tbody>
<tr>
<td>States + Washington D.C.</td>
<td>51</td>
<td>26</td>
<td>25</td>
</tr>
<tr>
<td>Population $^a$</td>
<td>100.0%</td>
<td>53.2%</td>
<td>46.8%</td>
</tr>
<tr>
<td>Average Medicaid Eligibility Thresholds $^b$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adults with Dependents</td>
<td>88.0%</td>
<td>114.6%</td>
<td>60.3%</td>
</tr>
<tr>
<td>Adults without Dependents</td>
<td>19.2%</td>
<td>37.7%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

$^a$ Source: 2013 Population estimates from the U.S. Census.
$^b$ Eligibility refers to income relative to the Federal Poverty Level for non-disabled working adults taken from “Status of State Action on the Medicaid Expansion Decision, 2014.” Kaiser Family Foundation.

Medicaid expansion impacts the reform outcomes. States that have chosen not to expand coverage have on average lower eligibility thresholds for non-elderly adults as compared to states which are expanding coverage. Average eligibility thresholds differ greatly with the presence of dependents within the household, which is a characteristic that is included in the model.

The ACA reforms that are modeled exclude the employer mandate and tax credits available to small businesses which provide incentives for employers to offer workers health insurance. Although employer based health insurance is the main source of private health insurance coverage among working age adults in the United States (Gruber, 2008; Fronstin, 2009) nongroup health insurance reforms and Medicaid expansion are likely to have a significant impact on the uninsured. The uninsured tend to be low income working age adults who are employed at smaller firms and are less likely to be offered insurance through their employer (Fronstin, 2009). According to Fronstin (2009), 49.7% of the uninsured are em-
ployed at firms with less than 25 employees and 62.5% are employed at firms with less than 100 employees. Concentration in smaller firms among the uninsured is relevant since firms with fewer than 50 full-time employees are exempt from the employer mandate which requires firms to offer health insurance or incur a fine.

This paper is related to the literature on dynamic stochastic general equilibrium modeling with heterogeneous agents (Bewley, 1986; Imrohoroglu, 1998; Imrohoroglu et al, 1995; Huggett, 1993; Aiyagari, 1994). The model features uninsurable labor productivity risk as in Aiyagari (1994) with the addition of partially insurable medical expenditure risk.

This paper is most closely related to the literature which adds medical expenditure risk and an endogenous health insurance purchase decision to heterogeneous agent models (Jeske and Kitao, 2009; Imrohoroglu and Kitao, 2012; Pashchenko and Porapakkarm, 2013; Janicki, 2013; Attanasio et al., 2011), and in particular research which focuses on the macroeconomic and welfare effects of the Affordable Care Act (Pashchenko and Porapakkarm, 2013; Janicki, 2013; Jung and Tran, 2011). Previous work focused on the implications of the reform in terms of coverage rates and welfare. This paper contributes to previous work by adding more heterogeneity in Medicaid eligibility for workers and focuses on the effects of excluding Medicaid expansion from the reform. The impact of the reform on saving incentives is studied, which has not been the focus of previous work. Additionally, the model considered in this paper is able to closely match long run estimates of changes in the uninsured, and the fiscal impact of the reform as predicted by the
Congressional Budget Office (Elmendorf, 2012).

The paper is organized as follows: section 2 outlines the model economy; section 3 discusses the policy experiment; section 4 outlines the data used and section 5 discusses parameterization; section 6 presents numerical results, and section 7 concludes.

1.2 Model Economy

1.2.1 Demographics

The economy is populated with $J$ overlapping generations, and the population grows at a constant rate $n$. The age $j$ cohort represents a fraction $\mu_j$ of the total population where $\sum_{j=1}^{J} \mu_j = 1$. The exogenous probability of survival between ages $j$ and $j+1$ is given by $\psi_j$ where $\psi_J = 0$ and $0 < \psi_j < 1$ for $j < J$. Thus, the population shares satisfy the recursive relation,

$$\mu_j = \frac{\psi_j}{1 + n} \mu_{j-1}$$

Accidental bequests, denoted $B$, left by deceased agents are distributed to surviving and newly born agents in a lump sum manner.
1.2.2 Endowment and Preferences

Labor is supplied inelastically until mandatory retirement beginning in period \(j^R\). Agents are heterogeneous in their labor productivity \(e_j = \eta_{j,H} \times z_j\) which consists of a persistent stochastic component \(z_j\) and a deterministic age varying component \(\eta_{j,H}\) which depends on age \(j\) and health status \(H\). The dependence on health captures differences in income by health status observed in the data and incorporates the empirical finding that better health is associated with higher labor earnings (Currie and Madrian, 1999). The evolution of the persistent process over time is governed by the Markov transition matrix \(f_z(z_{j+1}|z_j)\). Gross labor earnings are the product of the equilibrium wage rate and the agent’s productivity, \(y_j = we_j\). In retirement agents receive Social Security benefits \(y_j = SS(\bar{y}(z_{j^{R-1}}))\) which are a function of the average labor earnings in the period prior to retirement, conditional on \(z_{j^{n-1}}\).\(^1\) Ideally, Social Security benefits would depend on the entire earnings history, but doing so greatly increases the computational burden.

Agents have time separable, CRRA preferences over non-medical consumption \(c_j\), and seek to maximize the discounted sum of expected utility,

\[
E \left[ \sum_{j=1}^{J} \beta^{j-1} \frac{e_j^{1-\sigma}}{1 - \sigma} \right]
\]

where \(\beta\) is the discount factor and \(\sigma\) is the coefficient of relative risk aversion.

\(^1\)Agents with the same realization of \(z_{j^{n-1}}\) receive the same Social Security benefits during retirement independent of their health status in period \(j^R - 1\).
1.2.3 Medical Expenditure Shocks, Health Status

Agents differ along two health related dimensions - health status and medical expenditure shocks. Health status $H_j$ is drawn from the finite set $\mathcal{H}$ and evolves over time according to the Markov transition matrix $f_H(H_{j+1}|H_j, j, ins_j)$, which depends on current health status, age and health insurance coverage $ins_j$. Agents face exogenous medical expenditure shocks each period drawn from a finite set $m_j \in \mathcal{M}_j$ which varies with age. The probability of receiving a certain medical expenditure shock is conditional upon the agent’s health status and is given by $f_m(m_j|H_j)$.

1.2.4 Health Insurance

Health insurance coverage, denoted $ins_j$, is endogenous. Workers choose between nongroup insurance ($ins_j = N$), group insurance ($ins_j = G$) if they receive an offer through their employer, remaining uninsured ($ins_j = NI$) or obtaining coverage through Medicaid ($ins_j = MC$) which is means tested. All retirees are enrolled in the Government’s Medicare health insurance program ($ins_j = M$) and may receive additional coverage through Medicaid ($ins_j = MC$) if they qualify.

Insured agents whose realized medical expenditure shock is $m_j$ face out-of-pocket expenditures given by,

$$o(m_j, ins_j) = \min \{ m_j, \min \{ \gamma^{ins_j} + \rho^{ins_j} (m_j - \gamma^{ins_j}), M_L^{ins_j} \} \}$$
where \( \gamma_{insj} \) is the deductible, \( \rho_{insj} \) is the coinsurance rate and \( M_{Linsj} \) is the out-of-pocket spending limit. Uninsured agents face the full cost of the medical expenditure shock \( m_j \) so that \( o(m_j, NI) = m_j \). Health insurers cover a portion of the medical expenditure shock \( m_j \) given by,

\[
q_{insj}(m_j) = m_j - o(m_j, insj)
\]

The nongroup health insurance market differs from the group health insurance market in a few crucial ways. Health insurance coverage parameters differ between nongroup and group health insurers but are independent of the agents’ medical histories. This assumption implies that agents are not subject to lifetime spending caps by health insurers. Nongroup insurers are able to condition premiums on health status and age which determines the distribution over medical expenditure shocks whereas group health insurers cannot. This assumption follows from the Health Insurance Portability and Accountability Act of 1996 (HIPA) which prohibits discrimination in eligibility, coverage or premiums by group plans based on health factors. A third distinguishing feature of the two health insurance markets is that premiums paid to group insurers are excluded from taxable income. This benefit is not available for those purchasing nongroup insurance.
Private Health Insurance

There are two types of firms in the economy. One type offers group health insurance to its workers whereas the other does not. Let $i_G$ be an indicator function equal to 1 if the firm offers group health insurance and zero otherwise. The probability of being matched with a firm offering group health insurance depends on age and productivity $z_j$ and is given by $f_G(z_j, j)$. Firms offering group health insurance pay a portion $\phi$ of the group health insurance premium and the worker pays the remaining $(1 - \phi)P^G$. The firm’s offer rates do not change in response to the reforms.

All workers have access to the nongroup health insurance market. Nongroup insurance premiums $P^N_j(H_j)$ are conditioned on health status and age. The health insurance purchase decision is made after the realization of productivity, firm type and health status but before the medical expenditure shock is revealed. Nongroup insurers observe an agent’s age and health status and the conditional distribution over medical expenditure shocks.

Medicaid Insurance

Agents are eligible for coverage under the Government’s Medicaid health insurance program if their income falls below the threshold $y^{MC}(d_j)$,

$$y_j + r(k_j + B) < y^{MC}(d_j)$$
where \( r \) is the interest rate, \( k_j \) denotes savings, and the income eligibility threshold \( y^{MC}(d_j) \) depends on a demographic indicator \( d_j \). For working agents, the demographic indicator assumes a value of 1 if dependent children are present in the household, and zero if they are not. The evolution of the demographic indicator \( d_j \) is governed by the Markov transition function \( f_d(d_{j+1}|j,d_j) \) which depends on age and current demographics.

Medicaid eligibility for non-disabled working adults depends crucially on the presence of children within the household. The Personal Responsibility and Work Opportunity Act of 1996 extended Medicaid coverage to low income families with dependent children. States are not required to extend Medicaid coverage to non-disabled childless adults, and only nine states had categorical eligibility thresholds for this population in 2013.\(^2\) All retirees are eligible for Medicaid coverage if their income falls below the eligibility threshold \( y^{MC}_r \).

### 1.2.5 Health Insurers

Health insurers operate in a competitive environment. Group insurers charge premiums \( P^G \) and cover a portion \( q^G(m_j) \) of medical expenditures incurred by agents. Nongroup insurers charge premiums \( P^N_j(H_j) \) conditional on age and health status and cover a portion \( q^N(m_j) \) of medical expenditures in the current period. Premiums adjust to ensure that the zero expected profit condition holds for both

\(^2\)For more information on Medicaid eligibility levels by demographic characteristics see Artiga et al. (2013)
group and nongroup insurers,

\[
P^G = \frac{\omega^G \sum_{j=1}^{R-1} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) 1_{\{\text{ins}(s_j) = G\}} \left( \sum_{m_j \in M_j} q^G(m_j) f_m(m_j | H_j(s_j)) \right)}{\sum_{j=1}^{R-1} \mu_j \lambda_j(s_j) 1_{\{\text{ins}(s_j) = G\}}} \\
\]

(1.1)

\[
P^N_j(H_j) = \omega^N \sum_{m_j \in M_j} q^N(m_j) f_m(m_j | H_j) + \pi, \quad \forall j = 1, \ldots, j^R - 1; \quad H_j \in \mathcal{H}
\]

(1.2)

where \(\lambda_j(s_j)\) is the measure of age \(j\) agents in state \(s_j \in S_j\). The terms \(\omega^G \geq 1\) and \(\omega^N \geq 1\) denote markup factors for group and nongroup insurers, which are interpreted as administrative costs and \(\pi\) is a fixed cost associated with purchasing nongroup insurance. The indicator function \(1_{\{\text{ins}(s_j) = G\}}\) denotes whether an agent in state \(s_j\) purchases group health insurance in period \(j\). The numerator of equation (1) is the expected medical costs covered by the health insurer, and the denominator is the measure of agents who purchase group insurance.

1.2.6 Firms and Aggregate Production

Firms operate in a perfectly competitive environment and have access to a Cobb-Douglas production technology with constant returns to scale. The aggregate production function is given by,

\[
F(K, L) = AK^\alpha L^{1-\alpha}
\]
where $\alpha$ is capital’s share in production. Capital depreciates at a constant rate $\delta$ between periods. First order conditions from the firm’s profit maximization problem imply that factor prices satisfy,

$$r = A\alpha \left( \frac{K}{L} \right)^{a-1} - \delta$$

(1.3)

$$w = A(1 - \alpha) \left( \frac{K}{L} \right)^a$$

(1.4)

Aggregate capital and labor efficiency units are given by,

$$L = \sum_{j=1}^{R-1} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) e_j(s_j)$$

(1.5)

$$K = \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j)(k_j(s_j) + B)$$

(1.6)

Firms offering group health insurance pay a portion $\phi \in [0, 1]$ of the group premium. The wage rate paid by firms offering group health insurance adjusts to account for the employer subsidy in order to ensure that the zero profit condition holds. Firms offering group health insurance adjust wages by a factor $c_G$ which, following Jeske and Kitao (2009), takes the form,

$$c_G = \frac{\phi P^G \sum_{j=1}^{R-1} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j | i_G = 1) 1_{(\text{ins}_j(s_j) = G)}}{\sum_{j=1}^{R-1} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j | i_G = 1) e_j(s_j)}$$

The term in the numerator is the measure of agents who purchase group health insurance multiplied by the portion of the insurance premium paid by the em-
ployer. The denominator is the total labor supply in efficiency units for working agents who receive a group health insurance offer. The wage rate received by agents matched with a firm offering group health insurance is \( \tilde{w} = w - c_G \), independent of their health insurance purchase decision.

1.2.7 Government

The pay-as-you-go Social Security system pays retired agents benefits \( SS(\bar{y}(z_j^{R-1})) \), which are financed by a tax on labor earnings at a rate \( \tau_{SS} \) up to a threshold \( \bar{y} \). The Social Security tax rate adjusts to ensure that the balanced budget equation is satisfied,

\[
\sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) \tau_{SS} \min \{ y_j(s_j), \bar{y} \} = \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) SS(\bar{y}(z_j^{R-1})) \tag{1.7}
\]

The budget constraint for the Medicare program is given by,

\[
\sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) q^M(m_j(s_j)) = \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) P^M + \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) \tau_{MC} y_j(s_j) \tag{1.8}
\]

where \( \tau_{MC} \) is a payroll tax assessed on working agents which subsidizes the Medicare program and \( P^M \) is the Medicare premium. The cost of the Government’s Medicaid program is given by,

\[
G^{MC} = \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) q^{MC}(m_j(s_j)) MC^e(s_j)
\]
where \( MC^e(s_j) \) is an indicator function equal to one if the agent satisfies the Medicaid eligibility criteria as discussed in section 2.4.2 and zero otherwise.

The Government taxes economic activity to finance the cost of Medicaid, transfers to low income agents and an exogenous stream of consumption \( G \). Consumption is taxed at a linear rate \( \tau_c \), labor and capital income are taxed according to the function \( T_y(\tilde{y}) \) where \( \tilde{y} \) denotes taxable income defined as income less contributions to the Social Security and Medicare programs, premiums paid to group health insurers and out-of-pocket medical expenses which exceed 7.5% of income. The Government is not allowed to borrow and runs a balanced budget each period,

\[
G + G^{MC} + \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) Tr(s_j) = \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) \left[ T_y(\tilde{y}(s_j)) + \tau_c c_j(s_j) \right] 
\]

(1.9)

where \( Tr(s_j) \) denotes transfers to agents in state \( s_j \). Finally, the Government is responsible for transferring unintended bequests left by deceased agents. Bequests are evenly distributed in a lump-sum manner to surviving and newly born agents,

\[
B = \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j (1 - \psi_j) \lambda_j(s_j) k_{j+1}(s_j) 
\]

(1.10)

A safety net is provided to all agents in the form of a guaranteed consumption floor, \( c \). The consumption floor is intended to stand in for transfer programs such as TANF and food stamps for low income earners. Social insurance transfers, which are made net of out-of-pocket medical expenditures and the mandatory
Figure 1.1: Within Period Timing of Events

Medicare premium for retirees, take the form,

\[
Tr = \max \left\{ 0, c + PM_{j \geq j^R} + o(m_j, ins_j) - (y_j + (1 + r)(k_j + B) - T_y(\tilde{y}_j)) \right\}
\]

where \(1_{\{j \geq j^R\}}\) is an indicator function equal to one if the agent is retired.

1.2.8 The Agent’s Problem

The period \(j\) state space \(s_j\) which summarizes an agent’s status within the model consists of a level of savings \(k_j \in \mathbb{R}_+\), health status \(H_j \in \mathcal{H}\), medical spending shock \(m_j \in M_j\), productivity parameter \(e_j\), demographic indicator \(d_j \in \{0,1\}\) for working agents and firm type \(i_G\) indicating the availability of group insurance. The timing of events, depicted in figure 1.1, are as follows: agents enter each period with savings \(k_j\) and learn realizations of their health status \(H_j\), productivity parameter \(e_j\), demographic characteristics for working agents only and firm type \(i_G\) and then decide on health insurance coverage. Agents
then receive a medical expenditure shock, work and receive transfers from the
Government, pay out-of-pocket medical expenses and premiums (if applicable)
and make consumption and savings decisions.

Agents make saving, consumption and health insurance purchase decisions to
maximize expected lifetime utility. The agent’s optimization problem is written
recursively as,

\[
V_j(s_j) = \max_{c_j, k_{j+1}, ins_j} \left\{ \frac{c_j^{1-\sigma}}{1-\sigma} + \beta E_j[V_{j+1}(s_{j+1})] \right\} 
\]

s.t.

\[
(1 + \tau_c)c_j + o(m_j, ins_j) + k_{j+1} + P^{ins_j} = y_j + (1 + r)(k_j + B) + Tr - Tax
\]

\[
y_j = \begin{cases} 
(w - c_G \times i_G)e_j & j < j^R \\
SS(\tilde{y}(z_{j, n-1})) & j \geq j^R
\end{cases}
\]

Expectation is taken over future labor productivity, medical expenditures, health
status, demographic characteristics and firm type. Tax payments are given by,

\[
Tax = \begin{cases} 
\tau_{SS} \min\{y_j, \tilde{y}\} + \tau_{MC}y_j + T_y(\tilde{y}_j) & j < j^R \\
T_y(\tilde{y}_j) & j \geq j^R
\end{cases}
\]

where \(\tilde{y}_j\) is taxable income. For workers \(\tilde{y}_j\) is defined as labor and capital income
less Social Security and Medicare payroll taxes, premium payments to group in-
surers and medical expenditures which exceed 7.5% of income. For retirees, \(\tilde{y}_j\) is
defined as capital income less medical expenditures in excess of 7.5% of income.

During an agent’s working life, the decision to purchase health insurance is made by comparing expected utilities under each insurance arrangement before the medical expenditure shock has been realized. An agent decides to purchase health insurance if the expected utility from a given insurance arrangement exceeds the expected utility from other insurance options.

1.2.9 Stationary Competitive Equilibrium

Agents enter the economy with zero savings. The state space is defined by age \(j = 1, \ldots, J\), productivity \(e_j\), medical spending shock \(m_j \in M_j\), health status \(H_j \in \mathcal{H}\), savings \(k_j \in \mathbb{R}_+\), demographic characteristics \(d_j \in \{0, 1\}\) for working agents and firm type \(i_G\) indicating the availability of group insurance.

Given the exogenous probability of survival \(\{\psi_j\}_{j=1}^J\), transition functions \(\{f_z, f_H, f_m, f_G, f_d\}\) and initial distribution \(\lambda_1\) a stationary competitive equilibrium is a sequence of state contingent decision plans for the agent \(\{c_j(s_j), k_{j+1}(s_j), ins(s_j)\}_{j=1}^J\), production plans for the firm \(\{K, L\}\), insurance premiums \(\{P^G, P^N_j(H_j), P^M\}\), unintended bequests \(B\), taxes \(\{\tau_{SS}, \tau_{MC}, \tau_c, T_y(\tilde{y})\}\) and factor prices \(\{w, r\}\) such that

1. The private insurer’s budget constraints 1.1 and 1.2 hold.

2. Factor prices satisfy the firm’s first order conditions 1.3 and 1.4.

3. Markets clear so that 1.5 and 1.6 hold.
4. The Social Security and Medicare programs are self-financing so that 1.7 and 1.8 hold.

5. The Government’s budget balances 1.9.

6. Unintended bequests satisfy equation 1.10.

7. Given prices, Government policy, transfers and initial conditions the state contingent decision plans solves the agent’s problem 1.11.

8. The economy’s aggregate resource constraint holds,

\[ G + C + K' + M + X = AK^\alpha L^{1-\alpha} + (1 - \delta)K \]

where \( X \) denotes administrative spending on health insurance and,

\[ C = \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j)c_j(s_j), \]

\[ K' = \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j)k_{j+1}(s_j) \]

\[ M = \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j)m_j(s_j) \]

\[ X = \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) \left( m_j(s_j)\omega^G 1_{\{\text{ins}_{s_j}(s_j) = G\}} + (\pi + m_j(s_j)\omega^N) 1_{\{\text{ins}_{s_j}(s_j) = N\}} \right) \]

9. the distribution of agents over the state space satisfies \( \lambda_{j+1} = \Lambda(\lambda_j) \), where \( \Lambda(\cdot) \) is a one-period transition operator on the agent distribution.
1.3 Policy Experiment

The policy experiment consists of four sets of reforms - Medicaid expansion, nongroup regulations, cost-sharing subsidies and an individual mandate. Medicaid expansion is achieved through increasing the Medicaid eligibility threshold \( y^{MC} \) for working agents only, independent of demographic characteristics. Nongroup regulations include a community rating provision which restricts nongroup insurers to condition premiums only on age and minimum coverage requirements.

The reform includes cost-sharing in terms of premiums and coverage. The subsidy which limits spending on insurance premiums depends on income and is denoted \( s(inc_j) \) and the premium paid by the agent is given by \( \tilde{P}^{ins}_j = P^{ins}_j - s(inc_j) \). Premium subsidies are available to working agents purchasing nongroup insurance who are not eligible for Medicaid coverage, with incomes between 100% and 400% of the Federal Poverty Level and who haven’t received an offer to purchase insurance through the workplace. An exemption is provided if an employees’ contribution for employer provided insurance exceeds 9.5% of income.

The coverage cost-sharing subsidy limits out-of-pocket medical expenses for low income agents purchasing nongroup coverage. Under the reform out-of-pocket expenses are a function of the medical expenditure shock, insurance type and income and are given by \( o(m_j, ins_j, inc_j) \). Cost-sharing subsidies which limit out-of-pocket medical expenses in excess of what is provided by nongroup insurers are financed through Government transfers. Coverage subsidies are available to working agents purchasing nongroup insurance, with incomes between 100% and
250% of the Federal Poverty Level and who are ineligible for Medicaid coverage. Coverage subsidies are subject to the same conditions regarding employer provided insurance under the premium subsidies.

The individual mandate imposes a tax on those who choose to forgo health insurance coverage denoted $\tau_{IM}(inc_j, ins_j)$ which depends on income and insurance status. Exemptions are provided if out-of-pocket spending on insurance, premiums exceeds 8% of income, or if an individual’s income falls below the federal tax filing threshold.

In the reform economy, the working agent’s budget constraint is given by

\[
(1 + \tau_c)c_j + k_{j+1} + o(m_j, ins_j, inc_j) + \hat{p}^{ins_j} = y_j + (1 + r)(k_j + B) + Tr - Tax^R - \tau_{IM}(inc_j, ins_j)
\]

where $Tax^R$ denotes income taxation under the reform.

Nongroup insurance premiums are determined by the zero profit condition,

\[
P_j^N = \frac{\omega^N \sum_{s_j \in S_j} \mu_j^j \lambda_j^j(s_j) 1_{\{ins_j(s_j) = N\}} \left( q^{N,R}(m_j(s_j)) + \pi \right)}{\sum_{s_j \in S_j} \mu_j^j \lambda_j^j(s_j) 1_{\{ins_j(s_j) = N\}}} \quad \forall j = 1, \ldots, j^R - 1
\]

where $q^{N,R}(m_j)$ is portion of medical spending covered by the nongroup insurer which reflects the minimum coverage requirements. Premiums in the nongroup market are conditioned only on age and not health status in the reform economy which follows from the community rating restriction.

Under the reform the Government’s budget constraint includes spending at-
tributed to cost-sharing subsidies and revenue generated from the individual mandate tax,

\[
G + G^{MC} + \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) \left[ Tr(s_j) + s(inc_j(s_j)) \right] + \mathbf{1}_{\{\text{ins}_j(s_j) = N\}} \left( m_j(s_j) - q^{N,R}(m_j(s_j)) - o(m_j(s_j), \text{ins}_j(s_j), inc_j(s_j)) \right) = \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) \left[ T_y(\tilde{y}(s_j)) + \tau_{c,j}(s_j) + \tau_{IM}(inc_j(s_j), \text{ins}_j(s_j)) \right]
\]

1.4 The Medical Expenditure Panel Survey

Unless otherwise specified, the model is calibrated using data from the Medical Expenditure Panel Survey (MEPS). The MEPS consists of a series of two-year panel surveys administered by the Agency for Health Care Research and Quality to a nationally representative sample of employers, families and their medical providers. The analysis uses 10 panels from 2000/2001 to 2009/2010 consisting of 50,131 individuals.

The household component of the MEPS data contains information on wage earnings, medical spending and insurance status. Income is normalized to a base year of 2007 using the Consumer Price Index (CPI). Medical spending is normalized to a base year of 2007 using the CPI for medical care. Survey participants are grouped into Health Insurance Eligibility Units (HIEU) which includes family members who are eligible to receive coverage under their family’s health insurance plan. HIEU’s include adults, their spouses, children under the age of 18 and
children under 24 who are full time students. Data is used for the head of each household only. The MEPS data does not explicitly identify heads of household so, following Jeske and Kitao (2009), the household head for married couples is identified as the person with the highest income within each HIEU. A more detailed description of the data and calibration is provided in Appendix 1.A.

1.5 Parameterization

1.5.1 Demographics

Agents enter the model at age 25 with zero assets and death occurs with certainty at age 101. Each model period equates to one year so that \( J = 76 \) and retirement begins at age 65 so that \( j^R = 41 \). The population growth rate is 1.2% which is the average growth rate for the U.S. population from 1950 to 2007 according to the U.S. Census. The survival probabilities \( \{ \psi_j \}_{j=1}^J \), displayed in figure 1.2, are taken from the 2007 U.S. Actuarial Life Tables.
1.5.2 Medical Expenditure Shocks, Health Status

Health status is discretized into 4 states using the Physical Component Summary (PCS) score from the MEPS sample. The PCS is a continuous variable computed from 12 survey questions related to an individual’s general health, physical limitations and mental health state. Higher PCS scores correspond to better health. The algorithm used to create the PCS score is described in Ware et al. (1996).

MEPS sample respondents are sorted into four equally sized groups based on their PCS score. The four states are labeled poor health, fair health, good health and excellent health. Health status transition probabilities, $f_H(H_{j+1}|H_j, j, ins_j)$, are estimated from the 2-year MEPS sample using a multinomial logit model which controls for demographic measures, age and a binary indicator for health insurance coverage. Disabled individuals, identified as those receiving supplemental security income, are excluded from the estimation. The health insurance coverage indicator equals one for workers covered by private insurance and zero otherwise. Health transition probabilities are equal for the uninsured or those covered by Medicaid only. Relative to those with private insurance coverage, Medicaid patients are less likely to receive certain diagnostic procedures (Horner et al., 1995), more likely to face difficulty in obtaining services (Berk and Schur, 1998) and more likely to experience worse health outcomes relative to those with private insurance (Ayanian et al., 1993; Roetzheim et al., 2000; Bravemen et al., 1994). These empirical findings are reflected in the estimation strategy.
The initial distribution over health states is a weighted average of the invariant distributions associated with the Markov transition matrices of the uninsured and insured in the initial period, weighted by the fraction of 25 year old MEPS survey participants with private insurance coverage. The health status profiles over the life cycle are presented in figure 1.4. Realizations of health status over the life cycle are influenced by health insurance decisions. The model closely replicates the age profiles of each health status.

Medical expenditure shocks are estimated from each individual’s annual total health care expenditures as reported in the MEPS sample using a method similar to Jeske and Kitao (2009), Imrohoroglu and Kitao (2012) and Pashchenko
and Porapakkarm (2013). Individuals within the sample are sorted into 5 groups depending on where they fall within their age specific spending distribution corresponding to the 50th, 70th, 90th and 99th percentiles.

Medical expenditure shocks are estimated as the mean spending level within each age group, normalized by the sample average labor income of $33,024. Since the MEPS data only observes individuals up to age 85, a cubic polynomial is fit to each medical expenditure shock profile to smooth the profile and estimate shock values for ages 86 to 100. Medical expenditure shock age profiles and the fitted data profiles are provided in the appendix. The average medical spending age profiles produced by the model and observed in the MEPS sample are plotted in figure 1.3. The distribution of medical expenditure shocks, $f_m(m_j|H_j)$ is estimated as the fraction of the population within each of the 5 medical expenditure shock bins conditional on health status. The medical expenditure shock distribution conditional on health status is provided in the appendix.

The MEPS data, which consists of individual survey responses, underestimates aggregate medical expenditures compared to the National Health Expenditure Accounts (NHEA), which are based on provider revenue data. Sing et al. (2006) finds that the 2002 MEPS underestimates total medical expenditures by 13.8% compared to the NHEA. As discussed in Attanasio et al. (2011), the NHEA data are derived from provider surveys whereas the MEPS collects data from household surveys, which tend to under report spending and utilization. Following Attanasio et al. (2011), medical expenditure shocks estimated from the MEPS are scaled by a
factor of 1.232 to match the aggregate medical spending to GDP ratio of 15.85%, which is the average medical spending to GDP ratio from 2000-2010 according to the NHEA.

1.5.3 Endowment and Preferences

The coefficient of relative risk aversion $\sigma$ is set equal to 2 and the discount factor $\beta = 0.990455$ is calibrated so that the model produces a capital-output ratio of 3. The working agent’s labor endowment is characterized by a deterministic age component $\eta_{j,H}$ and a persistent component $z_j$. The deterministic age profiles are estimated from the regression,

$$inc = \beta_0 + \beta_1 age + \beta_2 age^2 + \beta_3 H + \beta_4 H \times age + \beta_5 H \times age^2 + \epsilon$$

where $inc$ is labor income normalized by the sample average labor income, $H$ denotes health status and $\epsilon$ is the error term. The age profiles produced from the estimates are presented in figure 1.5. Each profile is slightly hump shaped and peaks near age 50. Conditional on age, better health results in higher values of $\eta_{j,H}$ which translates into higher labor earnings. Variation in the health contingent age component accounts for 8.77% of the variation in log earnings among workers.

The persistent process is given by $z_j = \exp(\nu_j)$ where $\nu_j$ evolves according to,

$$\nu_{j+1} = \rho_2 \nu_j + \epsilon_j, \quad \epsilon_j \sim N(0, \sigma^2_\epsilon)$$
The persistent process is discretized into 7 equally spaced points ranging from $-2\sigma_z^2$ to $2\sigma_z^2$ using Tauchen’s (1986) method. The parameters governing the persistent process $\rho_z = 0.984$ and $\sigma_z^2 = 0.022$ are taken from Storesletten et al. (2004). Realizations of $z_j$ in the initial period are drawn from the distribution $N(0, 0.2704)$, where the variance is calibrated to match the variance of log earnings among 25 year olds of 0.323, according to Storesletten et al. (2004).

### 1.5.4 Health Insurance

The markup factors on private health insurance $\omega^G$ and $\omega^N$ are set equal to 1.11 following Kahn et al. (2005). The fixed cost associated with purchasing nongroup insurance $\pi = $496 is calibrated to match the takeup ratio of nongroup insurance among individuals younger than 65 observed in the MEPS sample. The two nongroup insurance parameters $\omega^N$ and $\pi$ imply that average administrative spending by nongroup insurers is 26.05% in the model compared to the estimated average of 30% according to Pauly and Nichols (2002) and Pauly et al. (1999).
The probability of being matched with a firm offering group insurance $f_G(z_j, j)$ is estimated from the logistic regression,

$$Pr(i_G = 1|z, j) = \frac{\exp(\beta_0 + \beta_1j + \beta_2j^2 + \beta_3z + \beta_4z \times j)}{1 + \exp(\beta_0 + \beta_1j + \beta_2j^2 + \beta_3z + \beta_4z \times j)}$$

where $j$ denotes age and $z$ is the persistent component of labor income. In the data the persistent component is calculated as labor income divided by the appropriate age component, and normalized by a constant so that the average persistent component in the data equals that of the model. The group insurance offer age profiles produced by the model and observed in the data are depicted in figure 1.6. The portion of the group premium paid by the employer, $\phi = 0.7114$ is calibrated to match the group insurance take up ratio produced by the model and observed in the data.

The parameters which govern the generosity of insurance coverage include the deductible $\gamma^{insj}$, coinsurance rate $\rho^{insj}$ and the out-of-pocket spending limit $M^{insj}_L$. All nominal variables are normalized by the MEPS sample average income. The deductible and out-of-pocket spending limit for group health insurance are set to $\gamma^G = \$1,040$ and $M^G_L = \$2,648$ following Claxton et al. (2012). The coinsurance rate is set to $\rho^G = 18.5\%$ following Sommers and Crimmel (2008).

Nongroup insurance parameters are taken from a comprehensive survey of nongroup health insurers (America’s Health Insurance Plan, 2009). Parameter values correspond to the reported averages for Preferred Provider Organization fam-
ily plans. The nongroup deductible is set to $\gamma^N = 5,514$ and the coinsurance rate is $\rho^N = 25.7\%$. The out-of-pocket spending limit for nongroup insurance is $M^N_L = 9,290$.

The Medicare deductible is set to $\gamma^M = 147$ and the coinsurance rate $\rho^M = 20\%$ which are taken directly from the Medicare Part B cost-sharing structure.\(^3\) Medicare does not provide protection against large out-of-pocket expenditure risk (Goldman and Zissimopoulos, 2003; Rapaport, 2009) and so no out-of-pocket spending limit is set for Medicare.

Medicaid’s cost-sharing structure varies by income but generally features a nominal deductible, low coinsurance rate and a low out-of-pocket maximum.\(^4\) The Medicaid deductible is set to $\gamma^{MC} = 0$, the coinsurance rate is set to $\rho^{MC} = 10\%$ and the out-of-pocket maximum is set to $M^{MC}_L = 5\% \times FPL$ where FPL is the Federal Poverty Level.

\subsection{1.5.5 Market Production}

The Cobb-Douglas technology available for production is $F(K, L) = AK^\alpha L^{1-\alpha}$. The value of $\alpha$ determines capitals share in production and is set equal to 0.33. The annual capital depreciation rate is set to 6\%. Total factor productivity $A = 0.6857$ is set such that the average labor income equals one when the capital output ratio is 3. Given individual behavior, the wage rate and interest rate are determined

\(^{3}\)For more information see \url{http://www.medicare.gov/your-medicare-costs/}  
\(^{4}\)For more information on Medicaid’s cost-sharing see \url{http://www.medicaid.gov/Medicaid-CHIP-Program-Information/By-Topics/Cost-Sharing/Cost-Sharing-Out-of-Pocket-Costs.html}
in general equilibrium from the firm’s profit maximizing first order conditions, equations (3) and (4).

1.5.6 Government

Government spending $G$ is chosen so that it accounts for 18% of aggregate output following Jeske and Kitao (2009). The consumption floor is set to $2,700 (in 1998 dollars) following De Nardi et al. (2010). The Federal Poverty Level (FPL) is set to $9,639 to match the fraction below 125% of the FPL of 17.41% which is the average over 2000-2010 according to the U.S. Census.

Medicaid eligibility for working agents differs by the demographic indicator $d_j$, which indicates the presence of children within the household. The transition function $f_d(d_{j+1}|j, d_j)$ is estimated using the 2-year MEPS panel from the logistic regression,

$$Pr(d_{j+1} = 1|j, d_j) = \frac{\exp(\beta_0 + \beta_1 j + \beta_2 j^2 + \beta_3 d_j + \beta_4 j \times d_j + \beta_5 j^2 \times d_j)}{1 + \exp(\beta_0 + \beta_1 j + \beta_2 j^2 + \beta_3 d_j + \beta_4 j \times d_j + \beta_5 j^2 \times d_j)}$$

where $d_j$ indicates the presence of dependent children within the household and $j$ denotes age. The age profile for dependents produced by the model, and observed in the MEPS data are presented in figure 1.7. The Medicaid eligibility threshold $y_{MC}(d_j = 0) = 0.613 \times FPL$ is calibrated to match the Medicare coverage rate among non-disabled working adults without dependents observed in the MEPS data. Similarly, the eligibility threshold $y_{MC}(d_j = 1) = 1.0695 \times FPL$ is calibrated to match the observed Medicare coverage rate among non-disabled working adults with dependents. The eligibility threshold for retirees, $y_r^{MC} = 0.685 \times FPL$
Figure 1.7: Dependents Age Profile

is calibrated to match the Medicaid coverage rate of 12.53% among retirees as observed in the MEPS sample.

The Government runs a Social Security system financed by a tax on labor income $\tau_{SS}$ which adjusts to ensure the program is budget balanced. Social Security taxes are applied to gross labor earnings up to the threshold $\bar{y} = $97,500, which is taken from the 2007 Social Security Trustees report. The piecewise linear function which determines Social Security benefits depends upon labor earnings in the period prior to retirement and features three bend points. The formula is taken from the 2007 Social Security Trustees report. Cutoff values are normalized by the MEPS sample average income.

$$SS(y_{j,n-1}) = \begin{cases} 
0.90 \times y_{j,n-1} & y_{j,n-1} < $8,160 \\
$7,344 + 0.32 \times (y_{j,n-1} - $8,160) & $8,160 \leq y_{j,n-1} < $49,200 \\
$20,477 + 0.15 \times (\min\{\bar{y}_{SS}, y_{j,n-1}\} - $49,200) & y_{j,n-1} \geq $49,200
\end{cases}$$

where $\bar{y}_{SS} = $81,968 which equates to the maximum allowable benefit level of $2,116 per month in 2007.

According to the 2008 Medicare Trustees Report, 12% of the program’s revenue
was generated from premiums, which is the fraction used in the model to determine the Medicare premium. The Medicare payroll tax $\tau_{MC}$ adjusts to ensure the program’s budget balances.

The proportional tax on consumption $\tau_c$ is equal to 5.67% following Mendoza et al. (1994). The income tax function consists of a non-linear progressive term and a proportion term. The progressive tax function, taken from Gouveia and Strauss (1994), approximates the U.S. income tax code. The proportional term accounts for additional non-income or consumption related taxes. The individual tax function is given by,

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

This functional form has been used in the public finance literature by Conesa and Krueger (2006), Conesa et al. (2009) and Jeske and Kitao (2009) among others. The parameter $a_0$ determines the level of the average tax rate and $a_1$ controls the progressiveness of the tax code. Gouveia and Strauss (1994) find that the values $a_0 = 0.258$ and $a_1 = 0.768$ best approximate the actual U.S. income tax code and are the values which are used in the analysis. The parameter $a_2 = 1.594$ is calibrated so that revenue generated from the progressive term in the income tax function accounts for 65% of Government revenue. The proportional term $\tau_y = 7.33\%$ ensures the Government’s budget balances.
Table 1.2: Nongroup Insurance Cost-Sharing Coverage Subsidies

<table>
<thead>
<tr>
<th>Income Relative to Federal Poverty Level</th>
<th>Actuarial Value</th>
<th>Insurance Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Deductible</td>
</tr>
<tr>
<td>100% - 150%</td>
<td>94%</td>
<td>$87</td>
</tr>
<tr>
<td>150% - 200%</td>
<td>87%</td>
<td>$483</td>
</tr>
<tr>
<td>200% - 250%</td>
<td>73%</td>
<td>$1,750</td>
</tr>
<tr>
<td>Greater than 250%</td>
<td>70%</td>
<td>$2,225</td>
</tr>
</tbody>
</table>

Source: Kaiser Family Foundation (2011)

1.5.7 Policy Experiment

In the policy experiment, a penalty is assessed on uninsured working agents equal to the maximum of 2.5% of their pretax income or $695, which is the penalty given in the ACA. Exemptions are provided if out-of-pocket spending on premiums exceeds 8% of income, or if income falls below the tax filing threshold. In the reform economy, the tax filing threshold is set equal to the Federal Poverty Level. Expansion of the Medicaid program is achieved through increasing the eligibility threshold to 133% of FPL for working agents under the reform, independent of demographic characteristics.

Nongroup insurance regulations include the community rating restriction, which prohibits premiums from being conditioned on health status. The receipt of premium cost-sharing subsidies is conditioned on the actuarial value of the health insurance plan offered. Since subsidies are only available for nongroup insurance plans with at least a 70% actuarial value (Jost, 2010) the nongroup insurance

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5In 2007, the tax filing threshold for a married couple younger than 65 years old filing jointly was $17,500 compared to the poverty level of $17,170 in 2007 for a family of three.
parameters are set equal to those achieving a 70% actuarial value as reported in table 1.2. Coverage parameters are taken from a survey conducted by the Kaiser Family Foundation (2011) of actuarial and benefit consulting firms who were asked to estimate insurance parameters to achieve a given actuarial value. Coverage subsidies provided by the ACA vary by income relative to the FPL as shown in table 1.2 and limit out-of-pocket expenditure risk by low income agents. Cost-sharing subsidies in excess of the 70% actuarial value provided by nongroup insurers under the reform are financed by the Government.

Subsidies provided for health insurance purchased through Government run insurance exchanges depends on income relative to the FPL and are such that premiums do not exceed a certain percentage of income as depicted in table 1.3. The spending limits determine the premium cost-sharing subsidy for those purchasing nongroup insurance. Cost-sharing subsidies are not available to Medicaid eligible agents or agents receiving an offer to purchase group insurance through their employer. An exemption is provided if the employee’s contribution for group

<table>
<thead>
<tr>
<th>Income Relative to Federal Poverty Level</th>
<th>Premium Expenditures Relative to Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% - 133%</td>
<td>2.0%</td>
</tr>
<tr>
<td>133% - 150%</td>
<td>3.5%</td>
</tr>
<tr>
<td>150% - 200%</td>
<td>5.2%</td>
</tr>
<tr>
<td>200% - 250%</td>
<td>7.2%</td>
</tr>
<tr>
<td>250% - 300%</td>
<td>8.8%</td>
</tr>
<tr>
<td>300% - 400%</td>
<td>9.5%</td>
</tr>
</tbody>
</table>

Source: Pashchenko and Porapakkarm (2013)
Table 1.4: Benchmark Model Fit

<table>
<thead>
<tr>
<th>Model</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical Spending to GDP Ratio</td>
<td>15.84%</td>
</tr>
<tr>
<td>Medical Spending Covered by Insurance</td>
<td>69.89%</td>
</tr>
<tr>
<td>Average Nongroup Premium to Average Income Ratio</td>
<td>12.58%</td>
</tr>
<tr>
<td>Group Premium to Average Income Ratio</td>
<td>9.94%</td>
</tr>
<tr>
<td>Average Saving Rate</td>
<td>6.85%</td>
</tr>
<tr>
<td>Earnings Gini Coefficient</td>
<td>0.528</td>
</tr>
<tr>
<td>Wealth Gini Coefficient</td>
<td>0.718</td>
</tr>
</tbody>
</table>

Private Health Insurance Coverage

<table>
<thead>
<tr>
<th>Model</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private Coverage (age &lt; 65)</td>
<td>66.89%</td>
</tr>
<tr>
<td>Nongroup Coverage</td>
<td>4.57%</td>
</tr>
<tr>
<td>Group Coverage</td>
<td>62.32%</td>
</tr>
<tr>
<td>Group Insurance Takeup Rate</td>
<td>92.22%</td>
</tr>
</tbody>
</table>

Medicaid Health Insurance Coverage

<table>
<thead>
<tr>
<th>Model</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retired (age ≥ 65)</td>
<td>12.52%</td>
</tr>
<tr>
<td>Non-Disabled Working Adults (age &lt; 65)</td>
<td>4.10%</td>
</tr>
<tr>
<td>Non-Disabled Working Adults with Dependents</td>
<td>8.82%</td>
</tr>
<tr>
<td>Non-Disabled working Adults without Dependents</td>
<td>2.65%</td>
</tr>
</tbody>
</table>

a Source: 2000-2010 National Health Expenditure Accounts (NHEA)
b Source: Average nongroup premium for family coverage (America’s Health Insurance Plan, 2009)
c Source: 2000-2010 Flow of Funds Accounts
d Source: Source: Díaz-Giménez et al. (2011)

insurance exceeds 9.5% of income.

1.6 Numerical Results

1.6.1 Benchmark Model

Table 1.4 presents aggregate statistics produced by the model and their counterparts observed in the data. Unless otherwise noted target statistics are taken
from the MEPS sample. Medical spending relative to GDP is identical between the model and the data according to the National Health Expenditure Accounts (NHEA). The portion of medical spending covered by health insurance is 69.89% in the model is lower than the 74.17% observed in the NHEA data. The average nongroup premium in the model is 12.58% of average income, compared to 15.68% in the data (America’s Health Insurance Plan, 2009). The model produces a group health insurance premium of 9.94% of average income which is close to the 10.47% observed in the MEPS data.

The average saving rate in the model is 6.85% compared to 5.35% in the 2000-2010 Flow of Funds Accounts. Wealth and earnings are less concentrated in the model as compared to estimates by Díaz-Giménez et al. (2011). Heterogeneity in productivity is limited within the model. Agents do not differ in ways that may reflect differences in human capital, nor is unemployment included in the model which may partially explain the difference in earnings concentration. The earnings concentration in part explains the inability of the model to match the wealth concentration observed in the data. Additionally, features important for explaining the wealth distribution such as bequest motives and entrepreneurship are not modeled (Cagetti and DeNardi, 2008).

Among working agents, the model produces a private insurance (nongroup plus group health insurance) coverage ratio of 66.89% compared with 66.90% observed in the MEPS sample. Group and nongroup coverage rates, which were targets in calibration, are identical between the model and the MEPS sample.
Group insurance takeup rate is 92.22% in the model and 90.83% in the MEPS sample. Medicaid coverage rates among retirees and non-disabled working adults with and without dependents are identical between the model and the MEPS sample. Medicaid coverage among non-disabled working adults is 4.10% in the model and 3.96% in the MEPS sample. The slight difference in Medicaid coverage rates among adults can be attributed to differences in demographics between the model and the MEPS data.

Figures 1.8 and 1.9 plot nongroup and group takeup rates over income deciles in the model and the MEPS data. Nongroup takeup rates are slightly decreasing over income deciles in the MEPS data. By contrast, nongroup takeup rates pro-
duced by the model are approximately hump shaped and peak in the sixth income decile. Group takeup rates produced by the model and observed in the MEPS sample, displayed in figure 1.9, are increasing over income deciles.

Figure 1.9 plots group and nongroup coverage rates over the working life span. The model closely matches the age profiles for group and nongroup coverage among working adults. Figure 1.11 plots the life cycle profiles for those without insurance coverage and those with medicaid coverage. The model over predicts the percent uninsured early in the life cycle, which can be attributed to differences in group coverage. The model closely matches the life cycle profile of Medicaid coverage observed in the MEPS data.

1.6.2 Reform Economy

Steady State Analysis

Given the fit of the baseline model discussed in the previous section, a policy experiment is conducted to quantify the effects from health insurance reforms in the ACA. All model parameters discussed in the parameterization section remain unchanged in the reform economy. Government expenditures $G$ remain unchanged from the baseline model and the proportional term in the income tax function $\tau_y$ adjusted to ensure the Government’s budget balances in the reform economy. Table 1.5 compares the baseline model with reform economies simulated with and without Medicaid expansion, which extends the eligibility threshold to 133% of the FPL independent of demographic characteristics.
Table 1.5: Steady State Comparison

<table>
<thead>
<tr>
<th></th>
<th>Baseline Economy</th>
<th>Medicaid Expansion</th>
<th>No Medicaid Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Premium</td>
<td>1.000</td>
<td>0.936</td>
<td>0.966</td>
</tr>
<tr>
<td>Cost Adjustment Term ($c_G$)</td>
<td>1.000</td>
<td>0.901</td>
<td>1.005</td>
</tr>
<tr>
<td>Aggregate Output</td>
<td>1.000</td>
<td>0.981</td>
<td>0.989</td>
</tr>
<tr>
<td>Aggregate Consumption</td>
<td>1.000</td>
<td>0.983</td>
<td>0.991</td>
</tr>
<tr>
<td>Aggregate Medical Spending</td>
<td>1.000</td>
<td>1.000</td>
<td>0.994</td>
</tr>
<tr>
<td>Capital Stock</td>
<td>1.000</td>
<td>0.942</td>
<td>0.962</td>
</tr>
<tr>
<td>Interest Rate</td>
<td>5.00%</td>
<td>5.46%</td>
<td>5.31%</td>
</tr>
<tr>
<td>Average Tax Rate</td>
<td>18.10%</td>
<td>20.58%</td>
<td>19.46%</td>
</tr>
<tr>
<td>Average Saving Rate</td>
<td>6.85%</td>
<td>7.83%</td>
<td>7.44%</td>
</tr>
<tr>
<td>Net Cost of Reform$^a$</td>
<td>–</td>
<td>3.97%</td>
<td>4.47%</td>
</tr>
</tbody>
</table>

**Health Insurance Coverage**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Uninsured</td>
<td>22.53%</td>
<td>6.79%</td>
<td>9.21%</td>
</tr>
<tr>
<td>Group (age &lt; 65)</td>
<td>62.32%</td>
<td>60.07%</td>
<td>64.99%</td>
</tr>
<tr>
<td>Nongroup (age &lt; 65)</td>
<td>4.57%</td>
<td>15.13%</td>
<td>19.59%</td>
</tr>
</tbody>
</table>

**Medicaid Coverage**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>All Working Adults</td>
<td>4.10%</td>
<td>16.05%</td>
<td>3.55%</td>
</tr>
<tr>
<td>Adults with Dependents</td>
<td>8.82%</td>
<td>15.03%</td>
<td>8.02%</td>
</tr>
<tr>
<td>Adults without Dependents</td>
<td>2.65%</td>
<td>16.36%</td>
<td>2.18%</td>
</tr>
</tbody>
</table>

**Welfare Calculations (Consumption Equivalent Variation)**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>C.E.V.</td>
<td>–</td>
<td>3.28%</td>
<td>1.77%</td>
</tr>
<tr>
<td>Percent with Welfare Gain</td>
<td>–</td>
<td>70.34%</td>
<td>70.44%</td>
</tr>
</tbody>
</table>

Note: Aggregate variables are normalized by baseline model values. Net cost of reform is cost sharing subsidies plus the costs associated with Medicaid expansion less taxes collected from the mandate.

$^a$ Relative to total government spending defined as the cost of social insurance transfers, Medicaid and the net cost of reform.

The reform significantly reduces the percent uninsured from 22.53% of the population in the baseline model to 6.79% when Medicaid is expanded, and 9.21% when Medicaid is not expanded. This compares to the estimated 7% of the nonelderly population uninsured according to the Congressional Budget Office.
over the period 2018-2022 (Elmendorf, 2012).\textsuperscript{6}

Group coverage decreases slightly when Medicaid is expanded and increases slightly when Medicaid is not expanded. The group premium decreases 6.4\% when Medicaid is expanded and 3.4\% when it is not. The relatively modest response from the reform to the group insurance market is supported by other research on the impacts of the ACA (Elmendorf, 2009; Gruber, 2011).

Nongroup coverage increases significantly in both reform economies relative to the baseline model. Private insurance coverage is greater when Medicaid is not expanded which is supported by the finding that Medicaid crowds out the purchase of private insurance (Gruber and Simon, 2008). The reduction in the percent uninsured is achieved through increases in Medicaid and nongroup insurance participation, when Medicaid is expanded and increases in nongroup participation when Medicaid is not expanded. Medicaid expansion results in significant increases in coverage among working adults both with and without dependents. Excluding Medicaid expansion from the reform results in a slight decrease in Medicaid coverage among both populations.

Private insurance coverage influences the realizations of health status, and therefore medical expenditure shocks. The reform produces a small reduction in aggregate medical spending relative to the baseline model. Aggregate output decreases by less than 2\% in both reform economies. Although not shown, aggregate

\textsuperscript{6}The period beginning in 2018, which is five years after implementation, was chosen as a starting point to allow for adjustment to law’s enactment. This estimate more closely corresponds to the model’s steady state analysis. The difference in the percent uninsured between the CBO estimate and the model prediction is partially explained by the fact that states are given the opportunity to expand Medicaid, which is not explicitly modeled in this paper.
labor supply increases slightly in the reform economies. The means tested cost-sharing subsidies, and minimum coverage requirements that reduce out-of-pocket expenditure risks for those purchasing nongroup insurance reduce savings incentives. The capital stock decreases 5.8% when Medicaid is expanded and 3.8% when Medicaid is not expanded.

The net cost of reform, relative to total government spending, is 3.97% when Medicaid is expanded and 4.47% when it is not. This compares to the Congressional Budget Office (Elmendorf, 2012) estimated net cost of 4.47% of Government spending over the period 2018-2022.\(^7\) To finance these expenditures average tax rates increase to 20.58% when Medicaid is expanded and 19.46% when Medicaid is not expanded.

The average saving rate increases in both reform economies relative to the baseline model. The average asset profile over the life cycle is plotted in figure

\(^7\)The net cost of the reform includes only costs associated with Medicaid expansion and exchange subsidies minus taxes collected from the uninsured. This estimate is normalized by total Government outlays from 2018-2022 taken from The Congressional Budget Office (2014) “The Budget and Economic Outlook: 2014 to 2024”
1.12. Similar reductions in savings are observed in both reform economies which are most evident between ages 35 and 65. Figure 1.13 plots average saving rates over income for working agents. Saving rates increase among those with incomes below 200% of the FPL, and decrease in each reform economy relative to the baseline economy for agents with incomes between 200% and 450% of the FPL. Average saving rates are nearly identical for agents with income in excess of 450% of the FPL. The average saving rate is calculated as the fraction of income net of taxation devoted to savings. Although the aggregate capital stock decreases in both reform economies, increases in the saving rate occurs in the reform economies because savings decreases to a lesser extent as compared to changes in income net of taxation.

**Welfare Comparisons**

Welfare changes between the baseline and reform economies are calculated in terms of consumption equivalent variation (C.E.V.) which measures the percentage increase in consumption required in all states of nature in the baseline model to equate expected utility of an agent born into the reform economy. Negative values correspond to welfare losses since agents born into the baseline economy require a decrease in consumption to equate expected utilities with an agent born into the reform economy.\(^8\)

As shown in table 1.5, reform includes Medicaid expansion results in an ex-

\(^8\)Let \(EV^B\) denote expected utility of an agent born into the baseline economy and \(EV^R\) denote expected utility of an agent born into the reform economy. CEV is defined as \(CEtitleV = (EV^B/EV^R)^{1/(1-\sigma)} - 1\)
The expected welfare gain equivalent to 3.28% of consumption. The expected welfare gain decreases to 1.77% of consumption when Medicaid is not expanded. When Medicaid is expanded 69.86% of those entering the reform economy experience a welfare gain relative to the baseline model. Excluding Medicaid expansion results in a slightly higher percentage who experience a welfare gain, but a lower expected welfare gain.

Welfare changes from the reform are further investigated in figures 1.14 and 1.15. Figure 1.14 presents welfare changes by age over the working agents life span in the two reform economies, relative to the baseline economy. Average welfare gains are increasing over the working life span, and expanding Medicaid...
results in higher expected welfare gains for each age as compared to the reform excluding Medicaid expansion. The increasing profile is partially explained by the average premium subsidy provided to low income earners purchasing nongroup insurance. As shown in figure 1.16, the average premium subsidy is increasing in age whereas the average coverage subsidy, shown in figure 1.17, remains relatively constant across the working life span. Figure 1.15 plots CEV over the working lifespan by demographics which indicates the presence of dependents. Welfare gains are approximately equal for the two demographic groups when Medicaid is not expanded. When Medicaid is expanded, agents without dependents \((d_j = 0)\) experience a larger welfare gain compared to those with dependents \((d_j = 1)\).

**Analysis of Insurance Coverage**

Figures 1.18-1.21 plot health insurance coverage profiles over the life cycle. The reform has a slight impact on the group insurance profile, which is less pronounced when Medicaid is not expanded. When Medicaid is not expanded, the reform increases group coverage among workers younger than 30, and has little impact on group insurance coverage for workers older than 30. Nongroup coverage increases among working agents relative to the baseline model. Nongroup coverage over the life cycle is higher when Medicaid is not expanded relative to the reform economy which includes Medicaid expansion. When Medicaid is not expanded, the Medicaid coverage profile is largely indistinguishable from the baseline profile. When Medicaid is expanded, Medicaid coverage increases the most.
among younger agents. The largest reduction in the uninsured is achieved among younger agents. Excluding Medicaid expansion increases the percent uninsured among the youngest workers. The difference in the percent uninsured between the reform models dissipates as agents age.

Table 1.6 presents an analysis of the uninsured in the baseline and reform economies. The individual mandate levies a tax on the uninsured to encourage the purchase of health insurance. Exemptions to the mandate tax apply if income falls below the tax filing threshold (the federal poverty level in the model), or if the cost of purchasing health insurance exceeds 8% of income.

Among the uninsured in the baseline model, 9.63% are below the poverty level
and the cost of purchasing insurance exceeds 8% of income for 35.22% of the uninsured. In the reform economy that includes Medicaid expansion, the cost of insurance is characterized as prohibitive for 66.59% of the uninsured and only 33.41% of the uninsured are subject to the mandate tax. When Medicaid is not expanded, 27.08% of the uninsured are subject to the mandate tax. The remainder fall into either of the exemption categories.

1.6.3 Analysis of Alternative Reforms

The previous section found that the reforms were able to achieve a large reduction in the percent uninsured. However, those below the poverty level are not eligible for cost-sharing subsidies or subject to the mandate. Exemptions also apply if the cost of insurance exceeds 8% of income. As a result less than 30% of the uninsured are subject to the mandate tax when Medicaid is not expanded. This section considers various changes to the reform and their impact on coverage rates. Table 1.7 presents results from the baseline model, reform without Medi-
caid expansion, reform that extends cost-sharing subsidies to those with incomes below the poverty level, reform without individual mandate tax exemptions and the reform excluding the community rating restriction. All alternative reforms are simulated without Medicaid expansion.

Extending subsidies further reduces savings incentives and leads to a reduction in the capital stock relative to the reform without Medicaid expansion. The net cost of the reform is highest in the extended subsidy model which results in the largest increase in the average tax rate among the reform economies compared to the baseline model. Removing either the mandate exemptions or the community rating restriction results in comparable decreases in the capital stock to the reform without Medicaid expansion.

Each of the three alternative reforms result in greater decreases in the percent uninsured as compared to the model without Medicaid expansion. The greatest reduction in the percent uninsured is achieved when the community rating restriction is removed. With community rating, healthier agents subsidize the cost of providing insurance to less healthy agents. This results in actuarially unfair insurance premiums for the healthiest and reduces their incentives to purchase insurance. In each reform economy, increases in insurance coverage are achieved through greater participation in the nongroup insurance market. Group coverage changes very little in each reform economy relative to the baseline model.

Extending subsidies to those with incomes below the poverty line results in higher expected welfare gains relative to the baseline model as compared to the
<table>
<thead>
<tr>
<th></th>
<th>Baseline Economy</th>
<th>No Medicaid Expansion</th>
<th>Extended Subsidy</th>
<th>No Mandate Exemptions</th>
<th>No Community Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Premium</td>
<td>1.00</td>
<td>0.966</td>
<td>0.954</td>
<td>0.953</td>
<td>0.959</td>
</tr>
<tr>
<td>Cost Adjustment Term ($c_G$)</td>
<td>1.00</td>
<td>1.005</td>
<td>0.975</td>
<td>1.006</td>
<td>1.001</td>
</tr>
<tr>
<td>Aggregate Output</td>
<td>1.00</td>
<td>0.989</td>
<td>0.984</td>
<td>0.991</td>
<td>0.990</td>
</tr>
<tr>
<td>Aggregate Consumption</td>
<td>1.00</td>
<td>0.991</td>
<td>0.986</td>
<td>0.992</td>
<td>0.991</td>
</tr>
<tr>
<td>Aggregate Medical Spending</td>
<td>1.00</td>
<td>0.994</td>
<td>0.993</td>
<td>0.993</td>
<td>0.993</td>
</tr>
<tr>
<td>Capital Stock</td>
<td>1.00</td>
<td>0.962</td>
<td>0.948</td>
<td>0.965</td>
<td>0.962</td>
</tr>
<tr>
<td>Interest Rate</td>
<td>5.00%</td>
<td>5.31%</td>
<td>5.42%</td>
<td>5.29%</td>
<td>5.32%</td>
</tr>
<tr>
<td>Average Tax Rate</td>
<td>18.10%</td>
<td>19.46%</td>
<td>19.98%</td>
<td>19.35%</td>
<td>19.50%</td>
</tr>
<tr>
<td>Average Saving Rate</td>
<td>6.85%</td>
<td>7.44%</td>
<td>7.64%</td>
<td>7.39%</td>
<td>7.42%</td>
</tr>
<tr>
<td>Net Cost of Reform</td>
<td>–</td>
<td>4.47%</td>
<td>6.07%</td>
<td>4.15%</td>
<td>4.53%</td>
</tr>
<tr>
<td>Uninsured</td>
<td>22.53%</td>
<td>9.21%</td>
<td>7.73%</td>
<td>5.51%</td>
<td>4.87%</td>
</tr>
<tr>
<td>Group (age &lt; 65)</td>
<td>62.32%</td>
<td>64.99%</td>
<td>63.84%</td>
<td>66.02%</td>
<td>65.23%</td>
</tr>
<tr>
<td>Nongroup (age &lt; 65)</td>
<td>4.57%</td>
<td>19.59%</td>
<td>23.15%</td>
<td>23.40%</td>
<td>24.84%</td>
</tr>
<tr>
<td>Medicaid Coverage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Working Adults</td>
<td>4.10%</td>
<td>3.55%</td>
<td>3.06%</td>
<td>3.49%</td>
<td>3.65%</td>
</tr>
<tr>
<td>Adults with Dependents</td>
<td>8.82%</td>
<td>8.02%</td>
<td>8.10%</td>
<td>7.91%</td>
<td>8.12%</td>
</tr>
<tr>
<td>Adults without Dependents</td>
<td>2.65%</td>
<td>2.18%</td>
<td>1.52%</td>
<td>2.14%</td>
<td>2.28%</td>
</tr>
<tr>
<td>Welfare Calculations (C.E.V.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.E.V.</td>
<td>–</td>
<td>1.77%</td>
<td>2.91%</td>
<td>1.46%</td>
<td>1.66%</td>
</tr>
<tr>
<td>Percent with Welfare Gain</td>
<td>70.44%</td>
<td>70.38%</td>
<td>67.33%</td>
<td>70.58%</td>
<td></td>
</tr>
</tbody>
</table>

Note: Alternative reforms are simulated without Medicaid expansion. “Extended Subsidy” provides cost-sharing subsidies below the poverty level. “No Mandate Exemptions” removes the mandate tax exemptions. Nongroup premiums are conditioned on health status and age under “No Community Rating.”
reform without Medicaid expansion. Expected welfare gains decrease when the mandate exemptions are removed. Compared to the reform without Medicaid expansion, removing community rating results in a small decrease in the expected welfare gain and a slight increase in the percentage experiencing an expected welfare gain.

1.6.4 Discussion of Model Assumptions and Extensions

**Exogenous Medical Spending:** Medical expenditures are modeled as an exogenous process. Purchasing health insurance effects the distribution over health status and hence the likelihood of experiencing an adverse medical expenditure shock. However, the model abstracts from any links between medical consumption and health outcomes. A more complete model might endogenize health capital and allow for choice over the level of medical consumption as in Grossman (1972). The role of insurance and the utility trade-offs featured in a model with endogenous spending are also present in the current model with exogenous spending shocks.

In a model with endogenous spending, health insurance may provide access to better technology and lower the marginal cost of medical consumption, which results in better health outcomes relative to the uninsured state. These benefits are featured in the current model where transition probabilities are conditional on insurance status. In the current model and a model with endogenous spending, insurance is purchased to reduce the costs associated with unforeseen future medical expenses (and possibly anticipated expenses when spending is endogenous). With
endogenous health capital agents have two dimensions for adjustment in response to a health shock. Current consumption can be substituted for medical spending to maintain health capital, or health capital can be allowed to depreciate in favor of consumption. In either case agents incur a utility cost associated with health shocks. With exogenous medical expenditure shocks, the utility cost associated with a negative shock occurs through lower consumption only. But in both instances agents make decisions regarding health insurance coverage by comparing the cost of purchasing insurance against the risk of remaining uninsured.

**Inelastic Labor Supply:** Working agents supply labor inelastically until mandatory retirement and therefore the model abstracts from any links between health, insurance and labor market decisions. There is considerable empirical evidence that health insurance plays a central role in retirement decisions and the reliance on employer based insurance as the main form of health insurance for workers inhibits job mobility (Gruber and Madrian, 2004).

Incorporating labor market frictions and endogenizing retirement would allow for an assessment of how the ACA impacts decisions along these dimensions. Inefficiencies created by job lock should be reduced for individuals eligible for cost-sharing subsidies which lower incentives to remain at a job due to insurance. However, individuals who are not eligible for subsidies face added incentives to remain in a job that provides health insurance: forgoing insurance results in a fine under the individual mandate. The impact on retirement decisions is also ambiguous. The ACA reforms reduce uncertainty over nongroup premiums and
low income earners benefit from subsidies which may encourage early retirement. The individual mandate increases the cost of retiring without insurance for those not eligible for Medicare, which may delay retirement for certain groups.

**Exogenous Employer Insurance Offers:** An interesting extension would be to endogenize the decision by employers to offer insurance to workers. Doing so would enable one to study the impacts of the ACA reforms that include tax credits to small firms who offer insurance and the employer mandate which imposes a tax on large firms who choose not to offer insurance. Even in the absence of these reform components a model with endogenous employer insurance offers would provide insight into how firms may respond to the nongroup reforms. The current model treats employer insurance offers as exogenous and therefore assumes that firms do not alter their insurance offer decisions in response to the ACA reforms.

**Endogenous Responses by Health Insurers:** Health insurance choices within the model are limited to a single group contract and a single nongroup contract. Responses to the reform are limited to nongroup insurers adjusting coverage parameters to meet minimum coverage requirements. The presence of community rating among nongroup insurers provides incentives for insurers to structure contracts in such a way so that individuals sort by health status. Allowing for multiple insurance contracts and enabling firms to respond endogenously to the reforms allows for an investigation into how insurers’ responses to the reforms impact coverage rates and welfare.
1.7 Conclusion

This paper develops a stochastic overlapping generations general equilibrium model with endogenous health insurance decisions to investigate the macroeconomic implications and welfare effects of nongroup health insurance reforms of the Patient Protection and Affordable Care Act (ACA) of 2010 and the impact of excluding Medicaid expansion from the reform. The focus on the Medicaid expansion and nongroup reforms of the ACA is motivated by the finding that the uninsured tend to be low income working age adults employed at smaller firms who have not received an offer to purchase health insurance through their employer (Fronstin, 2009). Since firms with fewer than 50 employees are not required to offer health insurance or incur a fine under the ACA, the nongroup insurance reforms, and Medicaid expansion, are likely to have a significant impact on the insurance purchase decisions of the uninsured.

The model is calibrated to match key moments of the U.S. economy and life cycle profiles observed in the MEPS data set. The reforms decrease the percent uninsured from 22.5% to 6.8% when Medicaid is expanded and 9.2% when Medicaid is not expanded. Reductions in the percent uninsured are achieved through increases in Medicaid and nongroup insurance coverage when Medicaid is expanded, and nongroup insurance coverage when Medicaid is not expanded. The reforms result in an expected welfare gain equivalent to 3.3% of consumption when Medicaid is expanded, and 1.8% when Medicaid is not expanded.

The individual mandate tax provides incentives for the uninsured to purchase
health insurance. Exemptions from the mandate tax are provided if income is below the tax filing threshold, or if the cost of purchasing insurance exceeds 8% of income. As a result of these exemptions, less than 35% of the uninsured are subject to the mandate tax. Higher rates of coverage can be achieved if the mandate tax exemptions are removed, if subsidies are extended below the poverty level or if community rating is excluded from the reform.
Bibliography


1.A Data Appendix

1.A.1 Sample Selection

Individuals surveyed for the MEPS are grouped according to Health Insurance Eligibility Units (HIEUs) which are defined as sub-family relationships comprised of adults plus any insurance eligible family members. The MEPS does not explicitly define the head of each HIEU so instead, following Jeske and Kitao(2009), the head of each HIEU is defined as the person with the highest labor income (using variable wagepY1x and wagepY2x, where Y1 and Y2 denotes the panel year). Individuals younger than 25 in the first panel year are dropped from the sample as are those older than 65 who report not being covered by Medicare. The resulting sample consists of 10 two-year panels from 2000/2001 until 2009/2010. Sample sizes are reported in table 1.8. All calculations utilize the longitudinal sample weights provided in the MEPS data.
1.A.2 Medical Expenditure Shocks

Medical expenditure shocks are estimated from the MEPS panel data using data on total medical expenditures (variables totexpY1 and totexpY2 for panel years 1 and 2) normalized by the sample average income of $33,024. Individuals are sorted into 5 bins depending on where they fall within their age specific spending distribution corresponding to the 50th, 70th, 90th and 99th percentiles. Medical expenditure shocks are calculated as the average medical expenditure within each bin and for each age group.

To calculate medical expenditure shocks for ages not observed in the sample, and to smooth the medical expenditure shock values over age, a cubic polynomial was fit to each data profile. The fitted polynomial was extended beyond the maximum age observed in the MEPS sample of 85 to estimate shock values. The medical expenditure shock profiles observed in the data and the fitted polynomials are displayed in figure 1.22.

The distribution of medical expenditure shocks is estimated as the fraction of
individuals observed in each medical expenditure shock bin conditional on health status. The distribution of medical expenditure shocks by health status is,

\[
    f_{m}(m_j | H_j) = \begin{pmatrix}
        0.327 & 0.190 & 0.274 & 0.181 & 0.029 \\
        0.507 & 0.206 & 0.200 & 0.080 & 0.007 \\
        0.588 & 0.195 & 0.161 & 0.053 & 0.004 \\
        0.577 & 0.209 & 0.166 & 0.046 & 0.002 
    \end{pmatrix}
\]

1.A.3 Productivity Shocks and Group Insurance Offer

The productivity process is characterized by a persistent component and an age varying deterministic component that depends on health status. Using labor income (variables wagepY1x and wagepY2x) from the MEPS sample, the deterministic component is estimated from the regression,

\[
    inc = \beta_0 + \beta_1 \text{age} + \beta_2 \text{age}^2 + \beta_3 H + \beta_4 H \times \text{age} + \beta_5 H \times \text{age}^2 + \epsilon
\]

where \( inc \) denotes income normalized by the sample average income and \( H \) denotes health status. OLS estimates are presented in table 1.9. The age profiles conditional on health status, which are displayed in figure 1.5, are calculated using the estimates from table 1.9.

MEPS participants were asked on three separate occasions whether they received an offer to purchase group insurance through the workplace (variables offer31x, offer42x, offer53x). Survey participants are assumed to receive an offer
Table 1.9: Age Component Estimation Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.32879</td>
<td>(0.16427)**</td>
</tr>
<tr>
<td>Age</td>
<td>0.04841</td>
<td>(0.00733)***</td>
</tr>
<tr>
<td>Age Squared</td>
<td>-0.00054</td>
<td>(0.00008)***</td>
</tr>
<tr>
<td>Fair Health</td>
<td>-1.11209</td>
<td>(0.20694)***</td>
</tr>
<tr>
<td>Good Health</td>
<td>-1.19515</td>
<td>(0.20070)***</td>
</tr>
<tr>
<td>Excellent Health</td>
<td>-1.37217</td>
<td>(0.19818)***</td>
</tr>
<tr>
<td>Age×Fair Health</td>
<td>0.06527</td>
<td>(0.00940)***</td>
</tr>
<tr>
<td>Age×Good Health</td>
<td>0.07995</td>
<td>(0.00920)***</td>
</tr>
<tr>
<td>Age×Excellent Health</td>
<td>0.09230</td>
<td>(0.00914)***</td>
</tr>
<tr>
<td>Age Squared×Fair Health</td>
<td>-0.00065</td>
<td>(0.00010)***</td>
</tr>
<tr>
<td>Age Squared×Good Health</td>
<td>-0.00082</td>
<td>(0.00010)***</td>
</tr>
<tr>
<td>Age Squared×Excellent Health</td>
<td>-0.00094</td>
<td>(0.00010)***</td>
</tr>
</tbody>
</table>

Significance at the 1% and 5% levels is denoted *** and ***, respectively.

to purchase group health insurance if they answered affirmatively to any of these three questions. Group insurance offer probabilities, $f_G(z_j, j)$, are estimated from the MEPS data with a logistic regression,

$$Pr(i_G = 1|z, j) = \frac{\exp(\beta_0 + \beta_1 j + \beta_2 j^2 + \beta_3 z + \beta_4 z \times j)}{1 + \exp(\beta_0 + \beta_1 j + \beta_2 j^2 + \beta_3 z + \beta_4 z \times j)}$$

where $j$ denotes age and $z$ is the persistent component of labor income, calculated as labor income divided by the health status contingent age component and normalized by a constant so that the average persistent component in the data equals that of the model. The estimated coefficients along with age and the values of the persistent component are used to calculate offer probabilities. The offer probabilities, conditional on age and productivity are displayed in figure 1.23.
1.A.4 Health Insurance

Health insurance coverage is determined using responses to monthly questions for group coverage (pegjaY1-pegdeY1 and pegjaY2-pegdeY2), nongroup coverage (prijaY1-prideY1 and prijaY2-prideY2) and Medicaid coverage (mcdjaY1-mcddeY1 and mcdjaY2-mcddeY2). An individual is assumed to be covered by group, nongroup or Medicaid if they were covered under either category for at least 7 months of the year. Medicare coverage is determined using the variables mcrevY1 for panel year 1 and mcrevY2 for panel year 2 which asks whether an individual was ever covered by public insurance during each panel year.

1.A.5 Health Status Transition Probabilities

Health status transition probabilities are estimated from the 2-year MEPS sample. Health status, which assumes four discrete states, is calculated from the physical component summary score contained in the MEPS. Survey respondents
### Table 1.10: Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Full Sample</th>
<th>Uninsured</th>
<th>Privately Insured</th>
<th>Retired</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Size</td>
<td>89,901</td>
<td>28,575</td>
<td>43,099</td>
<td>18,227</td>
</tr>
<tr>
<td>Demographic Variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>49.581</td>
<td>41.488</td>
<td>43.829</td>
<td>74.997</td>
</tr>
<tr>
<td>No High School Degree</td>
<td>0.195</td>
<td>0.332</td>
<td>0.092</td>
<td>0.305</td>
</tr>
<tr>
<td></td>
<td>(0.396)</td>
<td>(0.471)</td>
<td>(0.289)</td>
<td>(0.460)</td>
</tr>
<tr>
<td>High School Degree</td>
<td>0.446</td>
<td>0.473</td>
<td>0.425</td>
<td>0.468</td>
</tr>
<tr>
<td></td>
<td>(0.497)</td>
<td>(0.499)</td>
<td>(0.494)</td>
<td>(0.499)</td>
</tr>
<tr>
<td>College Degree</td>
<td>0.360</td>
<td>0.195</td>
<td>0.483</td>
<td>0.228</td>
</tr>
<tr>
<td></td>
<td>(0.480)</td>
<td>(0.396)</td>
<td>(0.500)</td>
<td>(0.419)</td>
</tr>
<tr>
<td>Married</td>
<td>0.435</td>
<td>0.296</td>
<td>0.528</td>
<td>0.353</td>
</tr>
<tr>
<td></td>
<td>(0.496)</td>
<td>(0.456)</td>
<td>(0.499)</td>
<td>(0.478)</td>
</tr>
<tr>
<td>Male</td>
<td>0.498</td>
<td>0.550</td>
<td>0.535</td>
<td>0.332</td>
</tr>
<tr>
<td></td>
<td>(0.500)</td>
<td>(0.497)</td>
<td>(0.499)</td>
<td>(0.471)</td>
</tr>
<tr>
<td>Health Related Variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCS Score</td>
<td>49.140</td>
<td>48.982</td>
<td>52.157</td>
<td>41.183</td>
</tr>
<tr>
<td></td>
<td>(10.664)</td>
<td>(10.858)</td>
<td>(8.204)</td>
<td>(12.083)</td>
</tr>
<tr>
<td>Smoker</td>
<td>0.218</td>
<td>0.360</td>
<td>0.196</td>
<td>0.101</td>
</tr>
<tr>
<td></td>
<td>(0.413)</td>
<td>(0.480)</td>
<td>(0.397)</td>
<td>(0.302)</td>
</tr>
<tr>
<td>Emergency Room Vists</td>
<td>0.190</td>
<td>0.241</td>
<td>0.136</td>
<td>0.273</td>
</tr>
<tr>
<td></td>
<td>(0.584)</td>
<td>(0.730)</td>
<td>(0.452)</td>
<td>(0.676)</td>
</tr>
<tr>
<td>Total Medical Spending</td>
<td>$4,346</td>
<td>$2,558</td>
<td>$3,549</td>
<td>$8,683</td>
</tr>
<tr>
<td></td>
<td>($12,015)</td>
<td>($8,279)</td>
<td>($12,104)</td>
<td>($14,377)</td>
</tr>
<tr>
<td>Income</td>
<td>$33,600</td>
<td>$19,009</td>
<td>$49,584</td>
<td>$8,261</td>
</tr>
<tr>
<td></td>
<td>($35,179)</td>
<td>($22,261)</td>
<td>($35,913)</td>
<td>($20,267)</td>
</tr>
</tbody>
</table>

Note: Standard deviations are reported in parentheses. Insured includes those covered by private insurance or Medicare for retirees.

* The Physical Component Summary (PCS) Score is a continuous variable ranging from 0-100 with higher values corresponding to better health.

...are sorted into four equally sized bins which are labeled poor health, fair health, good health and excellent health. Disabled individuals, identified as those receiving supplemental security income, are excluded from the estimation.

Transition probabilities, which are dependent on current health status, age and insurance coverage, are estimated from the 2-year MEPS panel using a multino-
mial logit model,

\[ Pr(H_2 = H_j) = \frac{\exp(\beta'_1 H_1 + \beta_{2j} ins_1 + \beta_{3j} ins_1 \times H_1 + \beta_{4j} ins_1 \times age_1 + \beta_{5j} X_1)}{1 + \sum_{k=1}^{3} \exp(\beta'_1 H_1 + \beta_{2k} ins_1 + \beta_{3k} ins_1 \times H_1 + \beta_{4k} ins_1 \times age_1 + \beta_{5k} X_1)} \]

where \( H_2 \) denotes health status in panel year 2, \( H_1 \) is a vector of dummy variables indicating health status in panel year 1, \( ins_1 \) indicates private insurance coverage among those younger than 65 in panel year 1 and \( age_1 \) denotes age in panel year 1. The vector \( X_1 \) contains demographic variables which includes age, age squared, a dummy variable indicating age greater than 65, education, marital status, total medical spending, income, gender, smoking status and the number of emergency room visits.

Excluding demographic measures from the model might bias the estimated effect of insurance coverage if differences in demographics between the insured and uninsured also influence health outcomes. Table 1.10 presents descriptive statistics for the full sample, the uninsured and privately insured working sample and retirees. Among the working population, the uninsured tend to be younger, less educated, in worse health, more likely to smoke, have lower incomes and spend less on medical care. On average, the uninsured visit the emergency room more frequently as compared to the privately insured. Emergency care represents one of the primary sources of health care for the uninsured (Pitts et al., 2010), and failure to control for this source of care could bias the estimated effect from private
Table 1.11: Health Transition Estimation Results

<table>
<thead>
<tr>
<th>Panel Year 2 Health Status</th>
<th>Fair Health</th>
<th>Good Health</th>
<th>Excellent Health</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intercept</strong></td>
<td>-0.210 (0.196)</td>
<td>-0.421 (0.228)</td>
<td>-0.352 (0.250)</td>
</tr>
<tr>
<td><strong>Health Variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fair Health</td>
<td>1.708 (0.052)***</td>
<td>2.431 (0.079)***</td>
<td>2.384 (0.097)***</td>
</tr>
<tr>
<td>Good Health</td>
<td>2.303 (0.076)***</td>
<td>3.879 (0.093)***</td>
<td>3.940 (0.107)***</td>
</tr>
<tr>
<td>Excellent Health</td>
<td>2.372 (0.096)***</td>
<td>3.947 (0.109)***</td>
<td>4.818 (0.118)***</td>
</tr>
<tr>
<td>E.R. Visits*</td>
<td>-0.141 (0.025)***</td>
<td>-0.213 (0.032)***</td>
<td>-0.318 (0.037)***</td>
</tr>
<tr>
<td>Medical Spending</td>
<td>-0.413 (0.057)***</td>
<td>-0.781 (0.088)***</td>
<td>-0.789 (0.100)***</td>
</tr>
<tr>
<td><strong>Demographic Variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retired</td>
<td>0.219 (0.074)***</td>
<td>0.215 (0.093)***</td>
<td>0.276 (0.108)**</td>
</tr>
<tr>
<td>Less Than H.S.</td>
<td>-0.081 (0.038)**</td>
<td>-0.207 (0.043)***</td>
<td>-0.224 (0.047)***</td>
</tr>
<tr>
<td>College Degree</td>
<td>0.066 (0.042)</td>
<td>0.127 (0.046)***</td>
<td>0.419 (0.047)***</td>
</tr>
<tr>
<td>Married</td>
<td>0.101 (0.034)***</td>
<td>0.080 (0.038)**</td>
<td>0.010 (0.040)</td>
</tr>
<tr>
<td>Income</td>
<td>0.156 (0.025)***</td>
<td>0.245 (0.026)***</td>
<td>0.270 (0.027)***</td>
</tr>
<tr>
<td>Male</td>
<td>0.113 (0.033)***</td>
<td>0.207 (0.037)***</td>
<td>0.124 (0.039)***</td>
</tr>
<tr>
<td>Smoker</td>
<td>-0.162 (0.039)***</td>
<td>-0.226 (0.043)***</td>
<td>-0.416 (0.046)***</td>
</tr>
<tr>
<td>Age</td>
<td>-0.013 (0.008)*</td>
<td>-0.043 (0.009)***</td>
<td>-0.046 (0.010)***</td>
</tr>
<tr>
<td>Age Squared</td>
<td>-1.2e−4 (7.62e−5)</td>
<td>2.79e−5 (9.48e−5)</td>
<td>-8.86e−5 (1.1e−4)</td>
</tr>
<tr>
<td><strong>Insurance Variables (Ins.)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insurance Coverage</td>
<td>0.275 (0.129)**</td>
<td>0.677 (0.154)***</td>
<td>0.537 (0.171)***</td>
</tr>
<tr>
<td>Age×Ins.</td>
<td>-0.000 (0.002)</td>
<td>-0.004 (0.002)*</td>
<td>-0.002 (0.003)</td>
</tr>
<tr>
<td>Fair Health×Ins.</td>
<td>-0.069 (0.073)</td>
<td>-0.241 (0.105)**</td>
<td>-0.414 (0.128)***</td>
</tr>
<tr>
<td>Good Health×Ins.</td>
<td>-0.143 (0.103)</td>
<td>-0.252 (0.123)**</td>
<td>-0.359 (0.140)**</td>
</tr>
<tr>
<td>Excellent Health×Ins.</td>
<td>-0.186 (0.130)</td>
<td>-0.279 (0.144)*</td>
<td>-0.250 (0.156)</td>
</tr>
</tbody>
</table>

Likelihood Ratio Tests

<table>
<thead>
<tr>
<th></th>
<th>D.F.</th>
<th>χ²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint Significance of Insurance Variables</td>
<td>15</td>
<td>86.21***</td>
</tr>
<tr>
<td>Joint Significance of Insurance Interaction Terms</td>
<td>12</td>
<td>26.68***</td>
</tr>
</tbody>
</table>

Poor health is the base case. Standard errors are reported in parenthesis. Significance at the 1%, 5% and 10% levels is denoted ***, ** and *, respectively.

*a E.R. denotes emergency room.

Insurance on health status.

Table 1.11 presents the estimated coefficients and standard errors from the multinomial logit estimation along with results from likelihood ratio tests which tested the joint significance of the insurance variables. Restricted models were estimated that excluded all insurance variables and only the interaction terms. All insurance variables, and the interaction terms are found to be jointly significant.
Annual transition probabilities, conditional on age health status and insurance coverage, are calculated using the estimates from table 1.11. For retirees, those older than 65, the insurance coverage variables are set to zero and the dummy variable for retirement is set equal to one. Individuals in the sample who are older than 65 and did not report Medicare coverage were dropped. The retirement dummy variable accounts for any variation in health outcomes among retirees that can be attributed to Medicare insurance coverage. Demographic variables are set equal to their sample averages.

Figure 1.24 plots the ratio of conditional transition probabilities over age for the uninsured relative to the privately insured. Values greater than one indicate
a higher probability of transitioning to a certain health state for the uninsured compared to the privately insured. As shown in the upper left plot, the uninsured have a higher probability of transitioning to poor health. With the exception of poor health, the uninsured have a higher probability of transitioning to fair health as shown in the upper right plot. The lower two plots indicate that the uninsured have a lower probability of transitioning to good and excellent health as compared to the privately insured.
1.B Computational Appendix

The algorithm used to compute the stationary equilibrium is as follows,

1. Discretize the state space for capital into $N_K = 500$ unevenly spaced points $k \in \{k_1, k_2, \ldots, k_{N_K}\}$ where the upper bound on the grid is chosen so that it does not represent a binding constraint on the agent’s problem.

2. Guess initial capital stock, insurance premiums, unintended bequests and cost adjustment factor for firms offering group health insurance and use the firm’s first order conditions to compute factor prices.

3. Solve the agent’s optimization problem recursively for state contingent policy functions.

4. Using the policy functions computed in step 3, the initial distribution of agents ($\lambda_1$) and the transition matrices for productivity, medical expenditure shocks, health status and firm type to solve for the distribution of agents through forward simulation.

5. Calculate the updated aggregate capital stock and unintended bequests ($K_1, B_1$) and equilibrium conditions.

6. If the capital stock, unintended bequests and equilibrium conditions are satisfied up to a convergence criteria of $\epsilon = 1^{-4}$ then stop; otherwise update insurance premiums, the capital stock, unintended bequests and the cost adjustment factor and return to step 2 until convergence is achieved.
Chapter 2

Reducing Medical Bankruptcies through Health Reform

2.1 Introduction

One of the legislative motives of the Patient Protection and Affordable Care Act (ACA) of 2010 is to reduce the high rate of bankruptcies caused in part by medical expenses.\textsuperscript{1} This is achieved through an expansion of Medicaid eligibility for low income workers, nongroup insurance regulations that include minimum coverage requirements, cost-sharing subsidies that limit out-of-pocket medical expenditure risk and an individual mandate which taxes the uninsured.

To study the impact of the ACA reforms on bankruptcy decisions an overlapping generations general equilibrium model is developed which includes stochastic

\textsuperscript{1}Affordable Care Act §1501(a)
medical expenditure shocks and endogenous health insurance and bankruptcy decisions. The model is calibrated to the U.S. economy using the Medical Expenditures and Panel Survey and Survey of Consumer Finances data sets. Agents can borrow and default on debt obligations by declaring bankruptcy. The bankruptcy process is modeled after Chapter 7 personal bankruptcy and is structured to capture features present in the current bankruptcy law. The health insurance framework is modeled after the U.S. health insurance system. Workers choose between tax preferred and employer subsidized group insurance if it’s offered through the workplace, nongroup insurance where premiums are conditioned on expected medical expenditures or obtaining coverage through Medicaid which is means tested. All retirees are enrolled in the Government’s Medicare insurance program.

The reforms reduce the percent uninsured from 23.5% in a baseline model to 6.6% when the reform includes Medicaid expansion and 7.5% when Medicaid is not expanded. Higher insurance coverage is achieved through greater participation in the nongroup market and the Medicaid program, when the reform includes Medicaid expansion. The focus on Medicaid expansion follows from the Supreme Court ruling (National Federation of Independent Business v. Sebelius, 2012) that states are not obligated to expand Medicaid eligibility.

The bankruptcy rate is reduced by 59% when Medicaid expansion is included in the reform, and 49% when Medicaid is not expanded. Medical bankruptcies decrease from 62% of all bankruptcies in a baseline model to 6% when the reform includes Medicaid expansion and 27% when Medicaid is not expanded. The cost-
sharing subsidies and individual mandate exemptions are crucial components for reducing medical bankruptcies. Further reductions can be achieved by extending cost-sharing subsidies to those with incomes below the poverty level. Greater reductions in the bankruptcy rate achieved when Medicaid is expanded is supported by empirical evidence which suggests that increases in Medicaid eligibility reduce personal bankruptcies (Grossa and Notowidigdo, 2011).

The reform without Medicaid expansion achieves a significant reduction in medical bankruptcies. Among those experiencing medical bankruptcies in the reform economy, the majority occur among those with incomes below the poverty level who are not eligible for Medicaid coverage. Medicaid’s medically needy program is found to reduce the incidence of medical bankruptcies. In addition to the ACA reforms, increasing the medically needy income limit to the categorical level further reduces the medical bankruptcy rate.

This paper is related three strands of literature. The first is the literature on dynamic stochastic general equilibrium modeling with heterogeneous agents (Bewley, 1986; Imrohoglu, 1998; Imrohogolu et al, 1995; Huggett, 1993; Aiyagari, 1994). The model features uninsurable labor productivity risk as in Aiyagari (1994) with the addition of partially insurable medical expenditure risk.

The second strand of literature adds unsecured borrowing and default to heterogeneous agent models. Livshits et al. (2007) study the effect of moving from a policy of purging debt in bankruptcy to an alternate form of bankruptcy which postpones payment. Chatterjee and Gordon (2012) consider the impact of elimi-
nating bankruptcy. Athreya et al. (2009) focus on the consumption variability in a model that includes unsecured credit and bankruptcy. This literature focuses on the consumption smoothing benefits afforded by bankruptcy and also includes uncertain spending shocks which are often modeled after medical expenses. The model in this paper contributes to this literature by adding health insurance which provides partial insurance for medical expenditure risk.

The third strand of literature adds medical expenditure risk and an endogenous health insurance purchase to heterogeneous agent models (Jeske and Kitao, 2009; Imrohoroglu and Kitao, 2012; Pashchenko and Porapakkarm, 2013; Janicki, 2013; Attanasio et al., 2010), and in particular the studies which focus on the macroeconomic and welfare effects of the Affordable Care Act (Pashchenko and Porapakkarm, 2013; Janicki, 2013; Kuklick, 2010). Previous work focused on the implications of the reform in terms of coverage rates and welfare. This paper contributes to the existing literature by incorporating bankruptcy decisions.

This paper is organized as follows: section 2 outlines the model economy, section 3 discusses policy experiment, section 4 describes the data sets used in the analysis, section 5 discusses parametrization, section 6 presents numerical analysis and section 7 concludes.
2.2 Model Economy

2.2.1 Demographics

The economy is populated by $J$ overlapping generations, and the total population grows at a constant rate $n$. The age $j$ cohort represents a fraction $\mu_j$ of the total population where $\sum_{j=1}^{J} \mu_j = 1$. The exogenous probability of survival between ages $j$ and $j + 1$ is given by $\psi_j$ where $\psi_J = 0$ and $0 < \psi_j < 1$ for $j < J$. Thus, the population shares satisfy the recursive relation,

$$\mu_j = \frac{\psi_j}{1 + n}\mu_{j-1}$$

2.2.2 Endowment and Preferences

Labor is supplied inelastically until mandatory retirement beginning in period $j^R$. Agents are heterogeneous in their labor productivity $e_j = \eta_{j,H} \times z_j$ which consists of a persistent stochastic component $z_j$ and a deterministic age varying component $\eta_{j,H}$ that depends on age $j$ and health status $H$. The dependence on health captures differences in income by health status observed in the data and incorporates the empirical finding that better health is associated with higher labor earnings (Currie and Madrian, 1999). The evolution of the persistent process over time is governed by the Markov transition matrix $f_z(z_{j+1}|z_j)$. Gross labor earnings are the product of the equilibrium wage rate and the agent’s productivity, $y_j = w e_j$. In retirement agents receive Social Security benefits $y_j = SS(\bar{y}(z_{j^R-1}))$. 
which are a function of the average labor earnings in the period prior to retirement, conditional on $z_{jR-1}$. Ideally, Social Security benefits would depend on the entire earnings history, but doing so greatly increases the computational burden.

Agents have time separable, CRRA preferences over non-medical consumption $c_j$, and seek to maximize the discounted sum of expected utility,

$$E \left[ \sum_{j=1}^{J} \beta^{j-1} \frac{c_j^{1-\sigma}}{1-\sigma} \right]$$

where $\beta$ is the discount factor and $\sigma$ is the coefficient of relative risk aversion.

### 2.2.3 Financial Intermediaries

Agents have access to financial intermediaries which operate in a competitive environment. Financial intermediaries accept deposits from savers and issue loans to borrowers that take the form of a one-period debt contract. Savers carry positive assets between periods so that $k_{j+1} \geq 0$ whereas borrowers carry negative assets between periods, $k_{j+1} < 0$. A one-period debt contract with a face value of $k_{j+1}$ implies that the borrower agrees to repay the lender $k_{j+1}$ in period $j + 1$ and is lent $q(k_{j+1}, s_j) \times k_{j+1}$ in period $j$. The price of a debt contract, $q(k_{j+1}, s_j)$, differs according to the size of the loan $k_{j+1}$ and the agent’s state $s_j$ in the current period, which is observable to the financial intermediary.

Debtors have the option of defaulting on their loan repayment and declaring

---

2 Agents with the same realization of $z_{jR-1}$ receive the same Social Security benefits during retirement independent of their health status in period $jR - 1$. 

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bankruptcy. In determining the loan price \( q(k_{j+1}, s_j) \) financial intermediaries use the agent’s optimal decision rule regarding default \( d(k_j, s_j) \) to forecast the probability of default as,

\[
\theta(k_{j+1}, s_j) = \sum_{s_{j+1} \in S_{j+1}} d(k_{j+1}, s_{j+1}) \Pi(s_{j+1}|s_j)
\]

where \( \theta(k_{j+1}, s_j) \) is the probability of default on a loan of size \( k_{j+1} \) for an agent in state \( s_j \) and \( \Pi(s_{j+1}|s_j) \) is the transition probabilities between states. Perfect competition among financial intermediaries implies the zero profit condition holds so that the price of a loan is given by,

\[
q_j(k_{j+1}, s_j) = \begin{cases} 
\frac{1}{1+r} & k_{j+1} \geq 0 \\
\psi_j(1 - \theta_j(k_{j+1}, s_j)) + \frac{\theta_j(k_{j+1}, s_j)\Gamma}{1+r} & k_{j+1} < 0
\end{cases}
\]  

(2.1)

where \( r \) is the equilibrium interest rate. The probability of non-repayment resulting from death is accounted for in the price of a loan. The amount of defaulted debt recovered by the financial intermediaries is denoted \( \Gamma \). Unintended bequests left by deceased savers are collected by the Government in the form of estate taxation.

### 2.2.4 Bankruptcy

Bankruptcy is structured to capture key aspects of the Bankruptcy Abuse Prevention and Consumer Protection Act (BAPCPA) of 2005 as it pertains to Chapter
bankruptcy, which allows for the full discharge of debt. Declaring bankruptcy
under Chapter 13, which reschedules debt repayment, is not explicitly modeled.
The BAPCPA imposes a means test of debtors seeking to file under Chapter 7
bankruptcy. The means test depends on the debtors income, median state income,
allowable consumption levels under Chapter 13 bankruptcy and the level of debt
(White, 2007).

There exists three forms of debt in the model - loans from financial interme-
diaries, out-of-pocket expenditures to health care providers, and divorce related
expenses. Declaring bankruptcy implies defaulting on all forms of debt. The
means test sets a consumption level \( c^B \) which determines eligibility for bankruptcy.
Agents with income above \( c^B \) who wish to file for bankruptcy will have any positive
assets and income above \( c^B \) seized as partial repayment to health care providers.
In the case that income above \( c^B \) exceeds medical bills, the remainder is collected
by financial intermediaries. Under chapter 7 an individual’s debt is discharged
whereas debt repayments are reorganized and continue under Chapter 13. Gar-
nishing income above the bankruptcy consumption floor for partial repayment of
debt captures the legislative intent of the means test in the BAPCPA.

If bankruptcy is declared with positive savings then assets and labor income
above the bankruptcy consumption floor are seized as partial payment to health
care providers. When bankruptcy is declared a tax \( \tau_B \) is incurred which accounts
for the monetary costs associated with declaring bankruptcy. Defaulters are re-
stricted from saving or borrowing in the period that bankruptcy is declared and
receive a bad credit rating $CS = 1$ in the following period which prohibits borrowing. Good credit rating is restored with probability $\pi$ each period.

### 2.2.5 Divorce Related Expenditure Shocks

Each period agents face an age dependent probability of incurring divorce related expenditures $\tau_D$. Let $DV \in \{0, 1\}$ be an indicator function equal to one if the divorce expenditure shock is incurred, and zero otherwise. The probability of incurring divorce expenses is given by $Pr(DV = 1|j) = f_D(j)$ which is dependent on age.

### 2.2.6 Medical Expenditure Shocks, Health Status

Agents differ along two health related dimensions - health status and medical expenditure shocks. Health status $H_j$ is drawn from the finite set $\mathcal{H}$ and evolves over time according to the Markov transition matrix $f_H(H_{j+1}|H_j, j, ins_j)$, which depends on current health status, age and health insurance coverage $ins_j$. Agents face exogenous medical expenditure shocks each period drawn from a finite set $m_j \in \mathcal{M}_j$ which varies with age. The probability of receiving a certain medical expenditure shock is conditional upon the agent’s health status and is given by $f_m(m_j|H_j)$. 
2.2.7 Health Insurance

Health insurance coverage, denoted $ins_j$, is endogenous. Workers choose between nongroup insurance ($ins_j = N$), group insurance ($ins_j = G$) if they receive an offer through their employer, remaining uninsured ($ins_j = NI$) or obtaining coverage through Medicaid ($ins_j = MC$) which is means tested. All retirees are enrolled in the Government’s Medicare health insurance program ($ins_j = M$) and may receive additional coverage through Medicaid ($ins_j = MC$) if they qualify.

For medical expenditure shock $m_j$ out-of-pocket expenditures are given by,

$$o(m_j, ins_j) = \min\left\{ m_j, \min\{ \gamma_{ins_j} + \rho_{ins_j}(m_j - \gamma_{ins_j}), M_{Lins_j} \} \right\}$$

where $\gamma_{ins_j}$ is the deductible, $\rho_{ins_j}$ is the coinsurance rate and $M_{Lins_j}$ is the out-of-pocket spending limit. Uninsured agents face the full cost of the medical expenditure shock $m_j$ so that $o(m_j, NI) = m_j$. Health insurers cover a portion of the medical expenditure shock $m_j$ given by,

$$q^{ins_j}(m_j) = m_j - o(m_j, ins_j)$$

The nongroup health insurance market differs from the group health insurance market in a few crucial ways. Health insurance coverage parameters differ between nongroup and group health insurers but are independent of the agents’ medical histories. This assumption implies that agents are not subject to lifetime spend-
ing caps by health insurers. Nongroup insurers are able to condition premiums on health status and age which determines the distribution over medical expenditure shocks whereas group health insurers cannot. This assumption follows from the Health Insurance Portability and Accountability Act of 1996 (HIPA) which prohibits discrimination in eligibility, coverage or premiums by group plans based on health factors. A third distinguishing feature of the two health insurance markets is that premiums paid to group insurers are excluded from taxable income. This benefit is not available for those purchasing nongroup insurance.

**Private Health Insurance**

There are two types of firms in the economy. One type offers group health insurance to its workers whereas the other does not. Let $i_G$ be an indicator function equal to 1 if the firm offers group health insurance and zero otherwise. The probability of being matched with a firm offering group health insurance depends on age and productivity $z_j$ and is given by $f_G(z_j, j)$. Firms offering group health insurance pay a portion $\phi$ of the group health insurance premium and the worker pays the remaining $(1 - \phi)P^G$.

All workers have access to the nongroup health insurance market. Nongroup insurance premiums $P^N_j (H_j)$ are conditioned on health status and age. The health insurance purchase decision is made after the realization of productivity, firm type, credit rating and health status but before the medical expenditure shock is revealed. Nongroup insurers observe age, health status and the conditional
distribution over medical expenditure shocks.

**Medicaid Insurance**

There exist two pathways to Medicaid eligibility. The first, categorical eligibility, is satisfied if income falls below the threshold $y^{MC}$,

$$y_j + r \times \max \left\{ 0, \frac{k_j}{1 + r} \right\} < y^{MC}$$

Let $MC^c$ be an indicator function which equals one if the categorical eligibility criteria are satisfied and zero otherwise. Categorical coverage is only available to workers without private insurance. The second pathway to Medicaid eligibility is by satisfying the medically needy criteria, which allows agents to spend down their assets to a threshold $k_{mn}^{MC}$ provided income net of medical expenditures falls below the threshold $y_{mn}^{MC}$,

$$y_j + r \times \max \left\{ 0, \frac{k_j}{1 + r} \right\} - \left( \tilde{o}(m_j, ins_j) - \max(0, k_j - k^{MC}) \right) < y_{mn}^{MC}$$

where $\tilde{o}(m_j, ins_j)$ denotes out-of-pocket spending before Medicaid coverage applies, which is used to determine medically needy eligibility. Let $MC_{mn}$ be an indicator function denoting medically needy eligibility. Out-of-pocket spending
for medically needy recipients is,

\[
o(m_j, MC^{mn}) = \min \left\{ \bar{o}(m_j, ins_j), \max(0, k_j - k_{mc}^{MC}) \right\} \\
+ o\left( \max(0, \bar{o}(m_j, ins_j) - \max(0, k_j - k_{mc}^{MC})) \right), MC \right\}
\]

The function which determines out-of-pocket expenditures for medically needy enrollments applies Medicaid coverage to out-of-pocket expenditures after assets have been spent down to the threshold \(k_{mc}^{MC}\). Medically needy coverage is not available to categorical Medicaid recipients.

### 2.2.8 Medical Providers

In the case of default, medical care providers receive payment from health insurers if the defaulting agent has purchased health insurance and payment from the agent if they have positive assets or income in excess of \(\zeta^B\). The cost of uncompensated care is passed on from medical care providers in the form of a proportional markup \(\eta\) of medical care costs. The medical providers clearing constraint is,

\[
\sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) m_j(s_j) = \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) \left[ (1 - d_j(s_j)) \eta \times m_j(s_j) \right. \\
+ d_j(s_j) (q^{ins} \eta \times m_j(s_j)) + \min \left\{ o(m_j(s_j), ins_j(s_j)), \max \{ 0, k_j(s_j) \} \right\} \\
+ \max \{ y_j(s_j) + Tr(s_j) - tax(s_j) - \zeta^B, 0 \} \left\} \right]
\]
where \( d(s_j) \) is the default decision of an agent in state \( s_j \), \( \text{tax} \) denotes income taxation and \( Tr \) denotes transfers from the Government.

### 2.2.9 Health Insurers

Health insurers operate in a competitive environment. Group insurers charge premiums \( P^G \) and cover a portion \( q^G(m_j) \) of medical expenditures incurred by agents. Nongroup insurers charge premiums \( P^N_j(H_j) \) conditional on age and health status and cover a portion \( q^N(m_j) \) of medical expenditures in the current period. Premiums adjust to ensure that the zero expected profit condition holds for both group and nongroup insurers,

\[
P^G = \frac{\omega^G \sum_{j=1}^{R-1} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) 1_{\{\text{ins}_j(s_j) = G\}} \left( \sum_{m_j \in M_j} q^G(m_j) f_m(m_j | H_j(s_j)) \right)}{\sum_{j=1}^{R-1} \mu_j \lambda_j(s_j) 1_{\{\text{ins}_j(s_j) = G\}}}
\]

(2.3)

\[
P^N_j(H_j) = \omega^N \sum_{m_j \in M_j} q^N(m_j) f_m(m_j | H_j) + \xi, \quad \forall j = 1, \ldots, j^R - 1; \quad H_j \in \mathcal{H}
\]

(2.4)

where \( \lambda_j(s_j) \) is the measure of age \( j \) agents in state \( s_j \in S_j \). The terms \( \omega^G \geq 1 \) and \( \omega^N \geq 1 \) denote markup factors for group and nongroup insurers, which are interpreted as administrative costs and \( \xi \) is a fixed cost associated with purchasing nongroup insurance. The indicator function \( 1_{\{\text{ins}_j(s_j) = G\}} \) denotes whether an agent in state \( s_j \) purchases group health insurance in period \( j \). The numerator of equation (2.3) is the expected medical costs covered by the health insurer, and...
the denominator is the measure of agents who purchase group insurance.

### 2.2.10 Firms and Aggregate Production

Firms operate in a perfectly competitive environment and have access to a Cobb-Douglas production technology with constant returns to scale. The aggregate production function is given by,

\[ F(K, L) = AK^\alpha L^{1-\alpha} \]

where \( \alpha \) is capital’s share in production. Capital depreciates at a constant rate \( \delta \) between periods. First order conditions from the firm’s profit maximization problem imply that factor prices satisfy,

\[ r = A\alpha \left( \frac{K}{L} \right)^{\alpha-1} - \delta \] \hspace{1cm} (2.5)

\[ w = A(1 - \alpha) \left( \frac{K}{L} \right)^{\alpha} \] \hspace{1cm} (2.6)

Aggregate capital and labor efficiency units are given by,

\[ L = \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) e_j(s_j) \] \hspace{1cm} (2.7)

\[ K = \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) \frac{\psi_j}{1 + n} q(k_{j+1}(s_j), s_j) k_{j+1}(s_j) + B \] \hspace{1cm} (2.8)
where $B$ denotes accidental bequests left by deceased agents.

Firms offering group health insurance pay a portion $\phi \in [0, 1]$ of the group premium. The wage rate paid by firms offering group health insurance adjusts to account for the employer subsidy in order to ensure that the zero profit condition holds. Firms offering group health insurance adjust wages by a factor $c_G$ which, following Jeske and Kitao (2009), takes the form,

$$
c_G = \frac{\phi P^G \sum_{j=1}^{R-1} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j | i_G = 1) \mathbb{1}_{\{\text{ins}_j(s_j) = G\}}}{\sum_{j=1}^{R-1} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j | i_G = 1) e_j(s_j)}
$$

The term in the numerator is the measure of agents who purchase group health insurance multiplied by the portion of the insurance premium paid by the employer. The denominator is the total labor supply in efficiency units for working agents who receive a group health insurance offer. The wage rate received by agents matched with a firm offering group health insurance is $\tilde{w} = w - c_G$, independent of their health insurance purchase decision.

### 2.2.11 Government

The pay-as-you-go Social Security system pays retired agents benefits $SS(\bar{y}(z_{j,R-1}))$, which are financed by a tax on labor earnings at a rate $\tau_{SS}$ up to a threshold $\bar{y}$. The Social Security tax rate adjusts to ensure that the balanced
budget equation is satisfied,

\[
\sum_{j=1}^{j_{R-1}} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) \tau_{SS} \min \{y_j(s_j), \tilde{y}\} = \sum_{j=j_{R}}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) SS(\tilde{y}(z_{j_{R}})) \tag{2.9}
\]

The budget constraint for the Medicare program is given by,

\[
\sum_{j=j_{R}}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) q^M(m_j(s_j)) = \sum_{j=j_{R}}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) P^M + \sum_{j=1}^{j_{R-1}} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) \tau_{MC} y_j(s_j) \tag{2.10}
\]

where \( \tau_{MC} \) is a payroll tax assessed on working agents which subsidizes the Medicare program. The cost of the Government’s Medicaid program for low income agents is given by,

\[
G^{MC} = \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) \left( MC^c(s_j) q^MC(\bar{o}(m_j(s_j), ins_j(s_j))) \right. \\
+ \left. MC^{mn}(s_j) q^MC \left( \max(0, \bar{o}(m_j(s_j), ins_j(s_j)) - \max(0, k_j(s_j) - k_{MC}^{mn}) \right) \right)
\]

The Government taxes economic activity to finance an exogenous stream of consumption \( G \). The Government collects bankruptcy taxes \( \tau_B \) and taxes consumption at a linear rate \( \tau_c \). Labor and capital income are taxed according to the function \( T_y(\tilde{y}) \) where \( \tilde{y} \) denotes taxable income which is defined as income less payroll taxes, premiums paid to group insurers and out-of-pocket medical expenditures that exceed 7.5% of income. Accidental bequests left by the deceased are
collected by the Government in the form of estate taxation,

\[B = \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) \frac{(1 - \psi_j)}{1 + n} \max\{q_j(k_{j+1}(s_j), s_j)k_{j+1}(s_j), 0\}\]  \hspace{1cm} (2.11)

The Government is not allowed to borrow and runs a balanced budget each period,

\[G + G^{MC} + \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j)Tr(s_j) = B + \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j)\left[T_y(\tilde{y}(s_j)) + \tau_c e_j(s_j)\right]\]  \hspace{1cm} (2.12)

where \(Tr(s_j)\) are denote transfers to agents in state \(s_j\).

The Government also provides a safety net available to all agents in the form of a guaranteed minimum level of consumption, \(c\) in the case that disposable assets fall below a certain threshold. The consumption floor is intended to stand in for transfer programs such as TANF and food stamps for low income individuals,

\[Tr = \max\{0, c + P^M 1_{(j \geq j_m)} - (y_j + \max\{0, k_j\} - tax)\}\]

Transfers are made net of mandatory Medicare premiums for retirees.

2.2.12 The Agent’s Problem

The period \(j\) state space \(s_j\) which summarizes an agent’s status within the model consists of savings \(k_j \in [k, \bar{k}]\), health status \(H_j \in \mathcal{H}\), medical spending shock \(m_j \in M_j\), productivity parameter \(e_j\), divorce status \(DV \in \{0, 1\}\), credit
Figure 2.1: Within Period Timing of Events

rating $CS \in \{0, 1\}$ and firm type $i_G \in \{0, 1\}$ indicating the availability of group health insurance in period $j$. The timing of events, depicted in figure 2.1, is as follows: agents enter each period with savings $k_j$ and learn realizations of their health status $H_j$, productivity parameter $e_j$ and firm type $i_G$ and credit rating $CS$ and then decide on health insurance coverage. Agents then receive medical and divorce expenditure shocks and make the default decision. They work, pay taxes and receive transfers to the Government. Loans, divorce expenses and out-of-pocket medical expenditures are paid unless bankruptcy is declared and consumption and savings decisions are made.

Agents make saving, consumption, default and health insurance purchase decision to maximize expected lifetime utility and solve the recursive optimization
problem,

\[ V_{j,\text{ins}_j}(s_j) = \max_{\{c_j, k_{j+1}, d_j\}} \left\{ \frac{c_j^{1-\sigma}}{1-\sigma} + \beta E_j[V_{j+1}(s_{j+1})] \right\} \]  

(2.13)

s.t.

\[(1 + \tau_c)c_j + o(m_j, \text{ins}_j) + q(k_{j+1}, s_j)k_{j+1} + P^{\text{ins}_j} + \tau_DDV = y_j + T_r + k_j - \text{tax} \quad (d_j = 0)\]

\[(1 + \tau_c)c_j + P^{\text{ins}_j} = \min\{y_j + T_r - \text{tax}, \underline{\epsilon}^B\} - \tau_B \quad (d_j = 1)\]

\[k_{j+1} \in \begin{cases} [k, \bar{k}] & CS = 0 \\ [0, \bar{k}] & CS = 1 \end{cases}\]

\[y_j = \begin{cases} (w - c_G \times i_G)e_j, & j < j^R \\ SS(\bar{g}(z_{j_{j-1}})), & j \geq j^R \end{cases}\]

\[V_{j+1}(s_{j+1}) = \begin{cases} V^0_{j+1}(s_{j+1}) & d_j = 0, \ CS = 0 \\ \pi V^0_{j+1}(s_{j+1}) + (1 - \pi)V^1_{j+1}(s_{j+1}) & d_j = 0, \ CS = 1 \\ V^1_{j+1}(s_{j+1}) & d_j = 1 \end{cases}\]

where \(V^0_{j+1}\) denotes period \(j + 1\) utility associated with a good credit rating and \(V^1_{j+1}\) is period \(j + 1\) utility associated with bad credit rating. Expectation is taken over future labor productivity, medical expenditures, health status, divorce
uncertainty, credit rating and firm type. Tax payments are given by,

\[
\text{tax} = \begin{cases} 
\tau_{SS}\{y_j, \tilde{y}\} + \tau_{MC}y_j + Ty_j & j < j^R \\
Ty_j(\tilde{y}_j) & j \geq j^R 
\end{cases}
\]

where \(\tilde{y}_j\) is taxable income. For workers \(\tilde{y}_j\) is defined as labor and capital income less Social Security and Medicare payroll taxes, premium payments to group insurers and medical expenditures that exceed 7.5% of income. For retirees \(\tilde{y}_j\) is defined as capital income less medical expenditures in excess of 7.5% of income.

Premium payments for health insurance, \(P^{ins}j\) are given by \((1-\phi)P^G\) for group health insurance, \(P^N_j(H_j)\) for nongroup insurance conditional on health status \(H_j\) and age \(j\), \(P^M\) for Medicare and zero if the agent has no health insurance or Medicaid insurance only.

Agents make default decisions by choosing the option that yields the highest utility for a given health insurance type. Default, consumption and savings decisions are made after all state variables have been realized. The health insurance purchase decision, which is made before the medical and divorce expenditure shocks have been realized, is made by comparing expected utilities under each health insurance arrangement where expectation is taken over divorce and medical expenditure shocks. Agent’s are aware of their categorical Medicaid eligibility at the time when the health insurance purchase decision is made. The period \(j\) value function is chosen as the maximum among all health insurance types as
\[ V_j(s_j) = \max \{ V_{j,NI}(s_j), V_{j,N}(s_j), V_{j,G}(s_j) \}. \]

### 2.2.13 Stationary Competitive Equilibrium

Agents enter the economy with zero savings and a good credit rating. The state space is defined by age \( j = 1, \ldots, J \), productivity \( e_j \), medical spending shock \( m_j \in M_j \), health status \( H_j \in \mathcal{H} \), saving \( k_j \in [k, \tilde{k}] \), divorce status \( DV \in \{0, 1\} \) and firm type \( i_G \in \{0, 1\} \) indicating the availability of group insurance.

Given the exogenous probability of survival \( \{ \psi_j \}_{j=1}^J \), transition functions \( \{ f_z, f_H, f_m, f_G, f_D, \pi \} \) and initial distribution \( \lambda_1 \) a stationary competitive equilibrium is a sequence of state contingent decision plans for the agent

\[
\{ c_j(s_j), k_{j+1}(s_j), ins_j(s_j), d_j(s_j) \}_{j=1}^J,
\]

production plans for the firm \( \{ K, L \} \), loan pricing function for financial intermediaries \( q(k_{j+1}, s_j) \), insurance premiums \( \{ P^G_j(H_j), P^M_j \} \), taxes \( \{ \tau_{SS}, \tau_{MC}, \tau_c, T_y(\tilde{y}), \tau_B \} \) and factor prices \( \{ w, r \} \) such that

1. Financial intermediaries earn zero profits and the loan pricing function satisfies (2.1)

2. The markup factor \( \eta \) on medical care adjusts so that the medical providers clearing constraint holds (2.2)

3. The private insurer’s budget constraints (2.3) and (2.4) hold.

4. Factor prices satisfy the firm’s first order conditions (2.5) and (2.6).

5. Markets clear so that (2.7) and (2.8) hold.
6. The Social Security and Medicare programs are self-financing so that (2.9) and (2.10) hold.

7. Unintended bequests are given by (2.11) and the Government’s budget balances (2.12)

8. Given prices, Government policy, transfers and initial conditions the state contingent decision plans solves the agent’s problem (2.13).

9. The economy’s aggregate resource constraint holds,

\[ G + C + M + K' + X = AK^{\alpha}L^{1-\alpha} + (1 - \delta)K \]

where \( X \) denotes divorce, bankruptcy resources and administrative spending on health insurance and and,

\[
C = \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j)c_j(s_j),
\]
\[
M = \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j)m_j(s_j)
\]
\[
K' = \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j)q_j(k_{j+1}(s_j), s_j)k_{j+1}(s_j)
\]
\[
X = \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) \left( m_j(s_j)\omega^G 1_{\{\text{ins}_{s_j}=G\}} + (\xi + m_j(s_j)\omega^N) 1_{\{\text{ins}_{s_j}=N\}} + d_j(s_j)\tau_B + (1 - d_j(s_j))DV \times \tau_D \right)
\]

10. the distribution of agents over the state space satisfies \( \lambda_{j+1} = \Lambda(\lambda_j) \), where
$\Lambda(\cdot)$ is a one-period transition operator on the agent distribution.

2.3 Policy Experiment

The policy experiment consists of four sets of reforms - Medicaid expansion, nongroup regulations, cost-sharing subsidies and an individual mandate. Medicaid expansion is achieved through increasing the Medicaid eligibility threshold $y^{MC}$ for workers only. Nongroup regulations include a community rating provision which restricts nongroup insurers to condition premiums only on age and minimum coverage requirements.

The reform includes cost-sharing in terms of premiums and coverage. The subsidy which limits spending on insurance premiums depends on income and is denoted $s(inc_j)$ and the premium paid by the agent is given by $\tilde{P}_{ins_j} = P_{ins_j} - s(inc_j)$. Premium subsidies are available to workers purchasing nongroup insurance who are not eligible for Medicaid coverage, with incomes between 100% and 400% of the Federal Poverty Level and who haven’t received an offer to purchase insurance through the workplace. An exemption is provided if an employee’s contribution for employer provided insurance exceeds 9.5% of income.

The coverage cost-sharing subsidy limits out-of-pocket medical expenses for low income agents purchasing nongroup coverage. Under the reform out-of-pocket expenses are a function of the medical expenditure shock, insurance type and income and are given by $o(m_j, ins_j, inc_j)$. Cost-sharing subsidies which limit out-
of-pocket medical expenses in excess of what is provided by nongroup insurers are financed through Government transfers. Coverage subsidies are available to working agents purchasing nongroup insurance, with incomes between 100% and 250% of the Federal Poverty Level and who aren’t eligible for Medicaid coverage. Coverage subsidies are subject to the same conditions regarding employer provided insurance under the premium subsidies.

The individual mandate imposes a tax on those who choose to forgo health insurance coverage denoted \( \tau_{IM}(inc_j, ins_j) \) which depends on income and insurance status. Exemptions are provided if out-of-pocket spending on insurance premiums exceeds 8% of income, if income falls below the federal tax filing threshold, or if bankruptcy is declared.

In the reform economy, the working agent’s budget constraint when not defaulting is given by

\[
(1 + \tau_c)c_j + o(m_j, ins_j, inc_j) + q_j(k_{j+1}, s_j)k_{j+1} + \tilde{P}^{ins_j} + \tau_D DV = y_j + k_j + Tr + tax^R - \tau_{IM}(inc_j, ins_j)
\]

where \( tax^R \) denotes income taxation under the reform.

Nongroup insurance premiums are determined by the zero profit condition,

\[
P^N_j = \omega^N \frac{\sum_{s_j \in S_j} \mu_j \lambda_j(s_j) 1_{\{ins_j(s_j) = N\}} \left( q^{N,R}(m_j(s_j)) + \xi \right)}{\sum_{s_j \in S_j} \mu_j \lambda_j(s_j) 1_{\{ins_j(s_j) = N\}}} , \quad \forall j = 1 \ldots j^R - 1
\]
where \( q^{N,R}(m_j) \) is portion of medical spending covered by the nongroup insurer which reflects the minimum coverage requirements. Premiums in the nongroup market are conditioned only on age and not health status in the reform economy which follows from the community rating restriction.

Under the reform the Government’s budget constraint includes spending attributed to cost-sharing subsidies and revenue generated from the individual mandate tax,

\[
G + G^{MC} + \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) \left[ Tr(s_j) + s(inc_j(s_j)) + 1_{\{ins_j(s_j) = N\}} (m_j(s_j) - q^{N,R}(m_j(s_j)) - o(m_j(s_j), ins_j(s_j), inc_j(s_j))) \right] = \\
B + \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) \left[ T_y(\tilde{y}(s_j)) + \tau_c c_j(s_j) + \tau_{IM} (inc_j(s_j), ins_j(s_j)) \right]
\]

### 2.4 Data

Data on household finances, divorce rates and bankruptcy filings are taken from the 2001, 2004, 2007 and 2010 Survey of Consumer Finances (SCF). Survey respondents younger than 25 were excluded from the analysis leaving a sample size of 91,544. The model period is 1 year so SCF bankruptcy rates correspond to whether respondents filed for bankruptcy in the previous year. Debt contracts in the model are one-period unsecured loans. Empirical estimates of debt use only credit card debt and excludes secured forms of debt such as real estate.

Earnings, group insurance offer rates, insurance coverage rates, health status
and medical expenditures are all estimated using data from the Medical Expenditure Panel Survey (MEPS). The MEPS consists of a series of two-year panel surveys administered by the Agency for Health Care Research and Quality to a nationally representative sample of employers, families and their medical providers. The analysis uses 10 panels from 2000/2001 to 2009/2010 consisting of 50,131 individuals.

The household component of the MEPS data contains information on wage earnings, medical spending and insurance status. Income is normalized to a base year of 2007 using the Consumer Price Index (CPI). Medical spending is normalized to a base year of 2007 using the CPI for medical care. Survey participants are grouped into Health Insurance Eligibility Units (HIEU) which includes family members who are eligible to receive coverage under their family’s health insurance plan. HIEU’s include adults, their spouses, children under the age of 18 and children under 24 who are full time students. Data is used for the head of each household only. The MEPS data does not explicitly identify heads of household so, following Jeske and Kitao (2009), the household head for married couples is identified as the person with the highest income within each HIEU. A more detailed description of the data and calibration is provided in Appendix 2.A.
2.5 Parametrization

2.5.1 Demographics

Agents enter the model at age 25 with zero assets and a good credit rating. Death occurs with certainty at age 101. Each model period equates to one year so that $J = 76$ and retirement begins at age 65 so that $j^R = 41$. The population growth rate is 1.2% which is the average growth rate for the U.S. population from 1950 to 2007 according to the U.S. Census. The survival probabilities $\{\psi_j\}_{j=1}^J$, displayed in figure 2.2, are taken from the 2007 U.S. Actuarial Life Tables.

2.5.2 Divorce Related Expenditure Shocks

The divorce expenditure shock $\tau_D = $148,000 is calibrated to match the percentage of bankruptcies attributed to medical expenditure shocks of 62.1% as reported in Himmelstein et al. (2009). The probability of incurring the divorce expenditure $f_D(j)$ is estimated from the SCF data using a logit regression of div-
vorce on age and age squared. SCF survey respondents are categorized as divorced if they reported having been divorced within five years of the survey. The divorce profiles used in the model, and observed in the data are presented in figure 2.3.

2.5.3 Medical Expenditure Shocks, Health Status

Health status is discretized into 4 states using the Physical Component Summary (PCS) score from the MEPS sample. The PCS is a continuous variable computed from 12 survey questions related to an individual's general health, physical limitations and mental health state. Higher PCS scores correspond to better health. The algorithm used to create the PCS score is described in Ware et al. (1996).

MEPS sample respondents are sorted into four equally sized groups based on their PCS score. The four states are labeled poor health, fair health, good health and excellent health. Health status transition probabilities, \( f_H(H_{j+1} | H_j, j, ins_j) \), are estimated from the 2-year MEPS sample using a multinomial logit model which controls for demographic measures, age and a binary indicator for health insurance coverage. Disabled individuals, identified as those receiving supplemental security income, are excluded from the estimation. The health insurance coverage indicator equals one for workers covered by private insurance and zero otherwise. Health transition probabilities are equal for the uninsured or those covered by Medicaid only. Relative to those with private insurance coverage, Medicaid patients are less likely to receive certain diagnostic procedures (Horner et al., 1995), more likely
to face difficulty in obtaining services (Berk and Schur, 1998) and more likely to experience worse health outcomes relative to those with private insurance (Ayanian et al., 1993; Roetzheim et al., 2000; Braveman et al., 1994). These empirical findings are reflected in the estimation strategy.

The initial distribution over health states is a weighted average of the invariant distributions associated with the Markov transition matrices of the uninsured and insured in the initial period, weighted by the fraction of 25 year old MEPS survey participants with private insurance coverage. The health status profiles over the life cycle are presented in figure 2.4. Realizations of health status over the life cycle are influenced by health insurance decisions. The model closely repli-
Medical expenditure shocks are estimated from each individual’s annual total health care expenditures as reported in the MEPS sample using a method similar to Jeske and Kitao (2009), Imrohoroglu and Kitao (2012) and Pashchenko and Porapakkarm (2013). Individuals within the sample are sorted into 5 groups depending on where they fall within their age specific spending distribution corresponding to the 50th, 70th, 90th and 99th percentiles.

Medical expenditure shocks are estimated as the mean spending level within each age group, normalized by the sample average labor income of $33,024. Since the MEPS data only observes individuals up to age 85, a cubic polynomial is fit to each medical expenditure shock profile to smooth the profile and estimate shock values for ages 86 to 100. Medical expenditure shock age profiles and the fitted data profiles are provided in the appendix. The average medical spending age profiles produced by the model and observed in the MEPS sample are plotted in figure 2.5. The distribution of medical expenditure shocks, $f_m(m|H_j)$ is estimated
as the fraction of the population within each of the 5 medical expenditure shock bins conditional on health status. The medical expenditure shock distribution conditional on health status is provided in the appendix.

The MEPS data, which consists of individual survey responses, underestimates aggregate medical expenditures compared to the National Health Expenditure Accounts (NHEA), which are based on provider revenue data. Sing et al. (2006) finds that the 2002 MEPS underestimates total medical expenditures by 13.8% compared to the NHEA. As discussed in Attanasio et al. (2011), the NHEA data are derived from provider surveys whereas the MEPS collects data from household surveys, which tend to underreport spending and utilization. Following Attanasio et al. (2011), medical expenditure shocks estimated from the MEPS are scaled by a factor of 1.216 to match the aggregate medical spending to GDP ratio of 15.85%, which is the average medical spending to GDP ratio from 2000-2010 according to the NHEA.

2.5.4 Endowment and Preferences

The coefficient of relative risk aversion $\sigma$ is set equal to 2 and the discount factor $\beta = 0.990453$ is calibrated so that the model produces a capital-output ratio of 3. The working agent’s labor endowment is characterized by a deterministic age component $\eta_{j,H}$ and a persistent component $z_j$. The deterministic age profiles are
estimated from the regression,

\[ inc = \beta_0 + \beta_1 \text{age} + \beta_2 \text{age}^2 + \beta_3 H + \beta_4 H \times \text{age} + \beta_5 H \times \text{age}^2 + \epsilon \]

where \( inc \) is labor income normalized by the sample average labor income, \( H \) denotes health status and \( \epsilon \) is the error term. The age profiles produced from the estimates are presented in figure 2.6. Each profile is slightly hump shaped and peaks near age 50. Conditional on age, better health results in higher values of \( \eta_{j,H} \) which translates into higher labor earnings. Variation in the health contingent age component accounts for 16.75% of the variation in log earnings among workers.

The persistent process is given by \( z_j = \exp(\nu_j) \) where \( \nu_j \) evolves according to,

\[ \nu_{j+1} = \rho_z \nu_j + \epsilon_j, \quad \epsilon_j \sim N(0, \sigma^2_\epsilon) \]

The persistent process is discretized into 5 equally spaced points ranging from \(-2\sigma^2_z\) to \(2\sigma^2_z\) using Tauchen’s (1986) method. The parameters governing the persistent process \( \rho_z = 0.95 \) and \( \sigma^2_\epsilon = 0.025 \) are taken from Livshits et al. (2010). Realizations of \( z_j \) in the initial period are drawn from the distribution \( N(0, 0.3513) \), where the variance is calibrated to match the variance of log earnings among 25 year olds of 0.323, according to Storesletten et al. (2004).
2.5.5 Bankruptcy

The bankruptcy consumption floor $c^B$, which determines the level above which income is garnished for partial repayment to debtors, is taken from the 2007 IRS standards for allowable living expenses.\textsuperscript{3} These standards are used in determining whether an individual is eligible to file under Chapter 7 bankruptcy (White, 2007). The consumption floor $c^B$ is calculated for a single person using the MEPS sample average income of $33,024 which yields the bankruptcy consumption floor of $c^B = 6,772$. Bankruptcy remains on a credit history for 10 years (Livshitz et al., 2007) so the probability of returning to good credit status is set to $\pi = 0.1$ so that the average duration in bad credit is 10 years. The tax associated with declaring bankruptcy is set to $\tau_B = 1,880$ to match the bankruptcy rate among SCF survey respondents younger than 65. This compares to an average of $1,078 spent on attorney fees in 2007 for Chapter 7 bankruptcy filing (Jones, 2008).

2.5.6 Health Insurance

The markup factors on private health insurance $\omega^G$ and $\omega^N$ are set equal to 1.11 following Kahn et al. (2005). The fixed cost associated with purchasing nongroup insurance $\xi = 309$ is calibrated to match the takeup ratio of nongroup insurance among individuals younger than 65 observed in the MEPS sample. The two nongroup insurance parameters $\omega^N$ and $\xi$ imply that average administrative

\textsuperscript{3}IRS allowable living expenses can be found at http://www.justice.gov/ust/eo/bapcpa/20070201/bci_data/national_expense_standards.htm
spending by nongroup insurers is 25.91% in the model compared to the estimated average of 30% according to Pauly and Nichols (2002) and Pauly et al. (1999).

The probability of being matched with a firm offering group insurance \( f_G(z, j) \) is estimated from the logistic regression,

\[
Pr(i_G = 1|z, j) = \frac{\exp(\beta_0 + \beta_1 j + \beta_2 j^2 + \beta_3 z + \beta_4 z \times j)}{1 + \exp(\beta_0 + \beta_1 j + \beta_2 j^2 + \beta_3 z + \beta_4 z \times j)}
\]

where \( j \) denotes age and \( z \) is the persistent component of labor income. In the data the persistent component is calculated as labor income divided by the appropriate age component, and normalized by a constant so that the average persistent component in the data equals that of the model. The group insurance offer age profiles produced by the model and observed in the data are depicted in figure 2.7. The portion of the group premium paid by the employer, \( \phi = 0.7677 \) is calibrated to match the group insurance take up ratio produced by the model and observed in the data.

The parameters which govern the generosity of insurance coverage include the
deductible $\gamma^\text{ins}_j$, coinsurance rate $\rho^\text{ins}_j$ and the out-of-pocket spending limit $M^\text{ins}_L$.

All nominal variables are normalized by the MEPS sample average income. The deductible and out-of-pocket spending limit for group health insurance are set to $\gamma^G = $1,040 and $M^G_L = $2,648 following Claxton et al. (2012). The coinsurance rate is set to $\rho^G = 18.5\%$ following Sommers and Crimmel (2008).

Nongroup insurance parameters are taken from a comprehensive survey of nongroup health insurers (America’s Health Insurance Plan, 2009). Parameter values correspond to the reported averages for Preferred Provider Organization family plans. The nongroup deductible is set to $\gamma^N = $5,514 and the coinsurance rate is $\rho^N = 25.7\%$. The out-of-pocket spending limit for nongroup insurance is $M^N_L = $9,290.

The Medicare deductible is set to $\gamma^M = $147 and the coinsurance rate $\rho^M = 20\%$ which are taken directly from the Medicare Part B cost-sharing structure. The out-of-pocket spending limit for Medicare $M^M_L = \tau_B - $1. In the SCF data, only 0.3\% of retirees report that they filed for bankruptcy in the previous year. Setting $M^M_L = \tau_B - $1 ensures that no retirees find it optimal to declare bankruptcy due to medical expenditure shocks.

Medicaid’s cost-sharing structure varies by income but generally features a nominal deductible, low coinsurance rate and a low out-of-pocket maximum. The Medicaid deductible is set to $\gamma^{MC} = $0, the coinsurance rate is set to $\rho^{MC} = 10\%$.

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4For more information see http://www.medicare.gov/your-medicare-costs/
5For more information on Medicaid’s cost-sharing see http://www.medicaid.gov/Medicaid-CHIP-Program-Information/By-Topics/Cost-Sharing/Cost-Sharing-Out-of-Pocket-Costs.html
and the out-of-pocket maximum is set to $M_{MC}^L = 5\% \times FPL$ where FPL is the Federal Poverty Level.

2.5.7 Market Production

The Cobb-Douglas technology available for production is $F(K, L) = AK^\alpha L^{1-\alpha}$. The value of $\alpha$ determines capitals share in production and is set equal to 0.33. The annual capital depreciation rate is set to 6%. Total factor productivity $A = 0.7285$ is set such that the average labor income equals one when the capital output ratio is 3. Given individual behavior, the wage rate and interest rate are determined in general equilibrium from the firm’s profit maximizing first order conditions, equations (3) and (4).

2.5.8 Government

Government spending $G$ is chosen so that it accounts for 18% of aggregate output (Jeske and Kitao, 2009). The consumption floor is set to $2,700 following De Nardi et al. (2010). The Federal Poverty Level (FPL) is set to $10,210 which is the Federal Poverty Level for a single individual in 2007.

The categorical Medicaid income eligibility threshold is $y_{MC}^L = 0.64 \times FPL$ is the median eligibility threshold for working adults (Kaiser Family Foundation, 2013). The medically needy eligibility threshold is set equal to $y_{mn}^MC = 0.3744 \times FPL$ and the asset limit is $k_{mn}^MC = $2,704 (Kaiser Family Foundation, 2012).

The Government run Social Security system is financed by a tax on labor income $\tau_{SS}$ which adjusts to ensure the program is budget balanced. Social Security
taxes are applied to gross labor earnings up to the threshold $\bar{y} = 97,500$, which is taken from the 2007 Social Security Trustees report. The piecewise linear function which determines Social Security benefits depends upon labor earnings in the period prior to retirement and features three bend points. The formula is taken from the 2007 Social Security Trustees report. Cutoff values are normalized by the MEPS sample average income.

$$SS(y_{j-1}) = \begin{cases} 
0.90 \times y_{j-1} & y_{j-1} < 8,160 \\
7,344 + 0.32 \times (y_{j-1} - 8,160) & 8,160 \leq y_{j-1} < 49,200 \\
20,477 + 0.15 \times (\min\{\bar{y}_{SS}, y_{j-1}\} - 49,200) & y_{j-1} \geq 49,200
\end{cases}$$

where $\bar{y}_{SS} = 81,968$ which equates to the maximum allowable benefit level of $2,116$ per month in 2007.

According to the 2008 Medicare Trustees Report, 12% of the program’s revenue was generated from premiums, which is the fraction used in the model to determine the Medicare premium. The Medicare payroll tax $\tau_{MC}$ adjusts to ensure the program’s budget balances.

The proportional tax on consumption $\tau_c$ is equal to 5.67% following Mendoza et al. (1994). The income tax function is taken from Gouveia and Strauss (1994) and takes the form,

$$T_y(\bar{y}) = a_0 \left[ \bar{y} - (\bar{y}^{-a_1} + a_2)^{-1/a_1} \right] + \tau_y \bar{y}$$
Gouveia and Strauss (1994) find that the values $a_0 = 0.258$ and $a_1 = 0.768$ best approximate the actual U.S. income tax code and are the values which are used in the benchmark analysis. The parameter $a_2 = 1.73$ adjusts so that tax revenue generated from the progressive term accounts for 65% of Government revenue. The proportional term $\tau_y = 0.0167$ adjusts to ensure the Government’s budget balances.

2.5.9 Policy Experiment

In the policy experiment, a penalty is assessed on uninsured working agents equal to the maximum of 2.5% of their pretax income or $695, which is the penalty given in the ACA. Exemptions are provided if out-of-pocket spending on premiums exceeds 8% of income, if income falls below the tax filing threshold or if bankruptcy is declared. In the reform economy, the tax filing threshold is set equal to the Federal Poverty Level.\(^6\) Expansion of the Medicaid program is achieved through increasing the eligibility threshold to 133% of FPL for working agents under the reform.

Nongroup insurance regulations include the community rating restriction, which prohibits premiums from being conditioned on health status. The receipt of premium cost-sharing subsidies is conditioned on the actuarial value of the health insurance plan offered. Since subsidies are only available for nongroup insurance plans with at least a 70% actuarial value (Jost, 2010) the nongroup

\(^6\)In 2007, the tax filing threshold for a married couple younger than 65 years old filing jointly was $17,500 compared to the poverty level of $17,170 in 2007 for a family of three.
Table 2.1: Nongroup Insurance Cost-Sharing Coverage Subsidies

<table>
<thead>
<tr>
<th>Income Relative to Federal Poverty Level</th>
<th>Actuarial Value</th>
<th>Insurance Parameters</th>
<th>Deductible</th>
<th>Coinsurance Rate</th>
<th>Out-of-Pocket Spending Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% - 150%</td>
<td>94%</td>
<td></td>
<td>$87</td>
<td>7.67%</td>
<td>$2,100</td>
</tr>
<tr>
<td>150% - 200%</td>
<td>87%</td>
<td></td>
<td>$483</td>
<td>20%</td>
<td>$2,100</td>
</tr>
<tr>
<td>200% - 250%</td>
<td>73%</td>
<td></td>
<td>$1,750</td>
<td>25%</td>
<td>$3,200</td>
</tr>
<tr>
<td>Greater than 250%</td>
<td>70%</td>
<td></td>
<td>$2,225</td>
<td>23.33%</td>
<td>$4,583</td>
</tr>
</tbody>
</table>

Source: Kaiser Family Foundation (2011)

insurance parameters are set equal to those achieving a 70% actuarial value as reported in table 2.1. Coverage parameters are taken from a survey conducted by the Kaiser Family Foundation (2011) of actuarial and benefit consulting firms who were asked to estimate insurance parameters to achieve a given actuarial value. Coverage subsidies provided by the ACA vary by income relative to the FPL as shown in table 2.1 and limit out-of-pocket expenditure risk for low income agents. Cost-sharing subsidies in excess of the 70% actuarial value provided by nongroup insurers under the reform are financed by the Government.

Subsidies provided for health insurance purchased through Government run insurance exchanges depends on income relative to the FPL and are such that premiums do not exceed a certain percentage of income as depicted in table 2.2. The spending limits determine the premium cost-sharing subsidy for those purchasing nongroup insurance. Cost-sharing subsidies are not available to Medicaid eligible agents or agents receiving an offer to purchase group insurance through their employer. An exemption is provided if the employee’s contribution for group insurance exceeds 9.5% of income.
Table 2.2: Nongroup Premium Cost-Sharing Subsidies

<table>
<thead>
<tr>
<th>Income Relative to Federal Poverty Level</th>
<th>Premium Expenditures Relative to Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% - 133%</td>
<td>2.0%</td>
</tr>
<tr>
<td>133% - 150%</td>
<td>3.5%</td>
</tr>
<tr>
<td>150% - 200%</td>
<td>5.2%</td>
</tr>
<tr>
<td>200% - 250%</td>
<td>7.2%</td>
</tr>
<tr>
<td>250% - 300%</td>
<td>8.8%</td>
</tr>
<tr>
<td>300% - 400%</td>
<td>9.5%</td>
</tr>
</tbody>
</table>

Source: Pashchenko and Porapakkarm (2013)

2.6 Numerical Analysis

2.6.1 Benchmark Model

Table 2.3 compares the model to the data in terms of medical spending, health insurance coverage, bankruptcy and debt. Medical spending relative to GDP matches the observed ratio according to data from the 2000-2010 National Health Expenditure Accounts (NHEA). Medical spending covered by insurance is 76.68% in the model compared to 74.9% according to the NHEA. Medical spending devoted to uncompensated care is 0.61% of total medical spending, compared with 2.4% according to Hadley et al. (2008). Uncompensated care is the cost of care for which payment was not received by medical providers which results from bankruptcy in the model. The model produces a group premium to average income ratio of 9.87% which is close to the estimated 10.47% observed in the MEPS data. The average nongroup premium is 7.9% of average income in the model which is less than the 15.68% according to a survey by America’s Health
Table 2.3: Benchmark Model Analysis

<table>
<thead>
<tr>
<th></th>
<th>Model</th>
<th>Data</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Medical Spending</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical Spending,GDP Ratio</td>
<td>15.84%</td>
<td>15.85%</td>
<td>2000-2010 NHEA</td>
</tr>
<tr>
<td>Medical Spending Covered by Insurance</td>
<td>76.68%</td>
<td>74.90%</td>
<td>2000-2010 NHEA</td>
</tr>
<tr>
<td>Uncompensated Care&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.61%</td>
<td>2.4%</td>
<td>Hadley et al. (2008)</td>
</tr>
<tr>
<td>Group Premium&lt;sup&gt;b&lt;/sup&gt;</td>
<td>9.87%</td>
<td>10.47%</td>
<td>MEPS Data</td>
</tr>
<tr>
<td>Average Nongroup Premium&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.90%</td>
<td>15.68%</td>
<td>AHIP (2009)</td>
</tr>
<tr>
<td><strong>Wealth, Earnings Inequality</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saving Rate</td>
<td>3.98%</td>
<td>5.35%</td>
<td>2000-2010 FFA</td>
</tr>
<tr>
<td>Earnings Gini Coefficient</td>
<td>0.383</td>
<td>0.636</td>
<td>Díaz-Giménez et al. (2011)</td>
</tr>
<tr>
<td>Wealth Gini Coefficient</td>
<td>0.785</td>
<td>0.816</td>
<td>Díaz-Giménez et al. (2011)</td>
</tr>
<tr>
<td><strong>Health Insurance Coverage</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group Take up Rate</td>
<td>90.24%</td>
<td>90.83%</td>
<td>MEPS Data</td>
</tr>
<tr>
<td>Group Coverage</td>
<td>62.32%</td>
<td>62.33%</td>
<td>MEPS Data</td>
</tr>
<tr>
<td>Nongroup Coverage</td>
<td>4.59%</td>
<td>4.57%</td>
<td>MEPS Data</td>
</tr>
<tr>
<td>Medicaid (&lt;age &lt; 65&gt;)</td>
<td>2.87%</td>
<td>3.96%</td>
<td>MEPS Data</td>
</tr>
<tr>
<td>Medicaid (&lt;age ≥ 65&gt;)</td>
<td>5.59%</td>
<td>12.53%</td>
<td>MEPS Data</td>
</tr>
<tr>
<td>Percent Medically Needy Enrollments</td>
<td>34.48%</td>
<td>17.80%</td>
<td>2000-2009 MSIS</td>
</tr>
<tr>
<td><strong>Bankruptcy</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bankruptcy Rate</td>
<td>1.11%</td>
<td>1.11%</td>
<td>SCF Data</td>
</tr>
<tr>
<td>Defaulting Without Insurance</td>
<td>76.24%</td>
<td>40.00%</td>
<td>Himmelstein et al. (2009)</td>
</tr>
<tr>
<td>Bankruptcy due to Medical Costs</td>
<td>62.17%</td>
<td>62.10%</td>
<td>Himmelstein et al. (2009)</td>
</tr>
<tr>
<td><strong>Debt</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent in Debt</td>
<td>3.04%</td>
<td>36.83%</td>
<td>SCF Data</td>
</tr>
<tr>
<td>Debt to Income Ratio in Bankruptcy</td>
<td>49.39%</td>
<td>30.43%</td>
<td>SCF Data</td>
</tr>
<tr>
<td>Average Debt to Income Ratio</td>
<td>8.92%</td>
<td>12.00%</td>
<td>2013 Economic Report of the President</td>
</tr>
</tbody>
</table>

<sup>a</sup> Uncompensated care is relative to aggregate medical spending.

<sup>b</sup> Ratios are relative to average income.

Data Sources: National Health Expenditure Accounts (NHEA), America’s Health Insurance Plan (AHIP), Flow of Funds Accounts (FFA), Medicaid Statistical Information System (MSIS).

Insurance Plan (2009).

The average saving rate in the model is 3.98% compared to an average of 5.35% in the 2000-2010 Flow of Funds Accounts data. Earnings is less concentrated in the model as compared to estimates by Díaz-Giménez et al. (2011). Productivity heterogeneity is limited in the model and the model abstracts from...
aspects such as differences in human capital or unemployment which may partially explain the lack of earnings concentration. Wealth is slightly less concentrated in the model compared to estimates by Díaz-Giménez et al. (2011).

The group take up rate, defined as the fraction purchasing group insurance conditional on an offer, is 90.24% in the model compared with 90.83% in the MEPS data. Group and Nongroup coverage among workers in the model match the estimated coverage rates observed in the MEPS data. Medicaid coverage produced by the model is close to what is observed in the MEPS data for those under 65 years old. Medicaid coverage among retirees is under predicted by the model compared to the MEPS data. Medically needy enrollments account for 34.48% of Medicaid enrollments in the model compared to 17.8% according to data from the 2000-2009 Medicaid Statistical Information System tables.

Figure 2.8 plots group and nongroup insurance coverage rates over age produced by the model and observed in the data. The model under predicts group coverage for those younger than 30. This results in an over prediction of the percent uninsured among those younger than 30 as shown in figure 2.9. The nongroup coverage profile produced by the model is slightly hump shaped whereas the data profile is flat. The model closely matches the Medicaid coverage profile over age as shown in figure 2.9.

The bankruptcy rates in the model matches that which is observed in the SCF data. The bankruptcy age profiles from the model and the data are presented in figure 2.10. The age profile produced by the model is slightly decreasing over age.
By contrast, the bankruptcy profile observed in the SCF data is highly variable over age. Among those who declare bankruptcy 76.24% are uninsured compared with an estimated 40% according to Himmelstein et al. (2009). Bankruptcies due to medical costs account for 62.17% of all bankruptcies in the model and 62.1% as estimated by Himmelstein et al. (2009). In the model, a bankruptcy is attributed to medical costs if not declaring bankruptcy is optimal when the lowest medical expenditure shock is realized, holding all other state variables constant.

The percent of the population in debt is 3.04% in the model compared to 36.83% of SCF survey respondents. The estimate from the SCF data corresponds to the percentage of survey respondents who carried a positive credit card balance.
Credit card debt most closely corresponds to the unsecured lending available to agents in the model. In bankruptcy the debt to income ratio is 49.39% in the model compared to 30.43% in the SCF data. The average debt to income ratio is 8.92% in the model and 12% according to data from the 2013 Economic Report of the President. The estimate from the 2013 Economic Report of the President uses data on revolving credit for debt and disposable income from 2000-2010.

2.6.2 Policy Experiment

Steady State Analysis

Given the fit of the baseline model, a policy experiment is conducted to determine the effects from nongroup health insurance reform measures in the ACA on health insurance coverage and bankruptcy rates. All model parameters discussed in the parametrization and calibration sections remain unchanged in the reform economy. Government expenditures $G$ remain unchanged from the baseline model and the tax parameter $\tau_y$ adjusts to ensure that the Government’s budget balances under the reform. Table 2.4 presents steady state comparisons of the baseline and reform economies simulated with and without Medicaid expansion.

Aggregate output decreases by 1.1% when Medicaid is expanded and remains unchanged when Medicaid is not expanded. Private insurance coverage influences health status outcomes which in turn impacts labor efficiency units. Aggregate labor supply increases marginally under both reform economies. The reforms weaken saving motives and reduces the capital stock in the reform economies. Precaution-
## Table 2.4: Steady State Comparison

<table>
<thead>
<tr>
<th></th>
<th>Baseline Economy</th>
<th>Medicaid Expansion</th>
<th>No Medicaid Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Premium</td>
<td>1.000</td>
<td>0.943</td>
<td>0.959</td>
</tr>
<tr>
<td>Aggregate Output</td>
<td>1.000</td>
<td>0.989</td>
<td>1.000</td>
</tr>
<tr>
<td>Aggregate Consumption</td>
<td>1.000</td>
<td>0.991</td>
<td>1.001</td>
</tr>
<tr>
<td>Medical Spending</td>
<td>1.000</td>
<td>0.997</td>
<td>0.993</td>
</tr>
<tr>
<td>Uncompensated Care</td>
<td>1.000</td>
<td>0.334</td>
<td>0.489</td>
</tr>
<tr>
<td>Capital Stock</td>
<td>1.000</td>
<td>0.962</td>
<td>0.993</td>
</tr>
<tr>
<td>Aggregate Labor Supply</td>
<td>1.000</td>
<td>1.002</td>
<td>1.004</td>
</tr>
<tr>
<td>Interest Rate</td>
<td>5.00%</td>
<td>5.30%</td>
<td>5.08%</td>
</tr>
<tr>
<td>Average Tax Rate</td>
<td>14.88%</td>
<td>16.45%</td>
<td>15.52%</td>
</tr>
<tr>
<td>Average Saving Rate</td>
<td>3.98%</td>
<td>4.58%</td>
<td>4.81%</td>
</tr>
<tr>
<td>Net Cost of Reforma</td>
<td>–</td>
<td>2.46%</td>
<td>3.94%</td>
</tr>
</tbody>
</table>

### Health Insurance Coverage

<table>
<thead>
<tr>
<th></th>
<th>Baseline Economy</th>
<th>Medicaid Expansion</th>
<th>No Medicaid Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uninsured</td>
<td>23.46%</td>
<td>6.60%</td>
<td>7.52%</td>
</tr>
<tr>
<td>Group Coverage</td>
<td>62.32%</td>
<td>62.31%</td>
<td>67.02%</td>
</tr>
<tr>
<td>Nongroup Coverage</td>
<td>4.59%</td>
<td>15.57%</td>
<td>20.02%</td>
</tr>
<tr>
<td>Medicaid (age &lt; 65)</td>
<td>2.87%</td>
<td>13.61%</td>
<td>3.27%</td>
</tr>
<tr>
<td>Percent Medically Needy</td>
<td>34.48%</td>
<td>0.18%</td>
<td>5.69%</td>
</tr>
</tbody>
</table>

### Bankruptcy and Debt

<table>
<thead>
<tr>
<th></th>
<th>Baseline Economy</th>
<th>Medicaid Expansion</th>
<th>No Medicaid Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bankruptcy Rate</td>
<td>1.11%</td>
<td>0.45%</td>
<td>0.57%</td>
</tr>
<tr>
<td>Defaulting Without Insurance</td>
<td>76.24%</td>
<td>9.95%</td>
<td>30.76%</td>
</tr>
<tr>
<td>Bankruptcy Due to Medical Costs</td>
<td>62.17%</td>
<td>5.58%</td>
<td>27.31%</td>
</tr>
</tbody>
</table>

### Welfare Calculations (Consumption Equivalent Variation)

<table>
<thead>
<tr>
<th></th>
<th>Baseline Economy</th>
<th>Medicaid Expansion</th>
<th>No Medicaid Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.E.V.</td>
<td>–</td>
<td>3.902%</td>
<td>3.489%</td>
</tr>
<tr>
<td>Percent With Welfare Gain</td>
<td>–</td>
<td>90.083%</td>
<td>100.000%</td>
</tr>
</tbody>
</table>

Note: Aggregate variables are normalized by baseline model values.
a Relative to total government spending defined as the cost of social insurance transfers, Medicaid and the net cost of reform.

ary saving incentives are weakened through increased coverage rates, cost sharing subsidies and minimum coverage requirements which limit out-of-pocket expenditure risk for those purchasing nongroup insurance. Despite the reduction in the capital stock, the average saving rate increases slightly in both reform economies. Medical spending is reduced by less than 1% under the reform economies. Changes in medical spending are driven by increases in private health insurance coverage
which results in better health outcomes.

The average tax rate increases under both reform economies to financed the additional costs associated with Medicaid expansion and the cost-sharing subsidies. The net cost of the reform, relative to total Government spending, is 2.46% when Medicaid is expanded and 3.94% when Medicaid is not expanded. By comparison, the Congressional Budget Office (Elmendorf, 2012) estimates the net cost of 4.47% of Government spending over the period 2018-2022.\footnote{The period beginning in 2018, which is five years after implementation, was chosen as a starting point to allow for adjustment to law’s enactment. This estimate more closely corresponds to the model’s steady state analysis. The net cost of the reform includes only costs associated with Medicaid expansion and exchange subsidies minus taxes collected from the mandate, normalized by total Government outlays from 2018-2022 taken from The Congressional Budget Office (2014) “The Budget and Economic Outlook: 2014 to 2024”}

The percent uninsured falls from 23.46% in the baseline model to 6.6% when Medicaid is expanded and 7.52% when Medicaid is not expanded. The estimated impact on insurance coverage rates compares favorably to the long run estimates by the Congressional Budget Office (Elmendorf, 2012) of 7% uninsured over the period 2018-2022. Reductions in the percent uninsured are achieved largely through increases in nongroup and Medicaid coverage when the reform includes Medicaid expansion. Excluding Medicaid expansion results in a greater increase in both group and nongroup coverage among workers as compared to the reform economy that expands Medicaid. In both reform economies the percent of Medicaid enrollments qualifying as medically needy decreases significantly relative to the baseline model.

Figures 2.11 and 2.12 display group and nongroup coverage rates over the
Figures 2.11 and 2.14 plot Medicaid coverage and the percent uninsured over the working life cycle. Group coverage remains relatively unchanged in the reform economies compared to the baseline model. Nongroup coverage increases at each age and most significantly among those younger than 45 years old. Excluding Medicaid expansion from the reform results in an increase in coverage among those younger than 30. The reform which excludes Medicaid expansion has little effect on Medicaid coverage rates for workers older than 30. Reductions in the percent uninsured are achieved at each age of the working life cycle and the largest reductions in the percent uninsured are achieved among those younger than 35 years old. When Medicaid is expanded near universal coverage
As shown in table 2.4, the reforms reduce the bankruptcy rate from 1.11% in the baseline model to 0.45% when Medicaid is expanded and 0.57% when Medicaid is not expanded. The percent of uninsured defaulters decreases significantly under both reform economies and to a greater extent when Medicaid is expanded. Fewer bankruptcies reduce the amount of uncompensated care provided, the cost of which is passed on from medical providers to non-defaulting health care consumers.

As a percent of all bankruptcies, medical bankruptcies decrease from 62.17% in the baseline model to 5.58% under the reform that includes Medicaid expansion. Excluding Medicaid expansion results in a decrease in the medical bankruptcy rate to 27.31%. Figure 2.15 displays bankruptcy rates over the working life cycle in the baseline and reform economies. The reform reduces bankruptcies at each age, and little difference exists between the profiles in the two reform economies for those older than 40. Excluding Medicaid expansion from the reform results in a
smaller decrease in bankruptcies among workers younger than 40.

Welfare changes are calculated in terms of consumption equivalent variation (C.E.V.), which measures the percentage change in consumption required to equate expected utilities between the baseline and reform economies.\(^8\) Negative values correspond to welfare losses since agents entering the baseline economy require a decrease in consumption to equate expected utility with an agent entering the reform economy.

As shown in table 2.4 implementing the reform with Medicaid expansion results in a welfare gain equivalent to 3.9% of consumption and 90% of agents entering the reform economy experience a welfare gain. Excluding Medicaid expansion results in a slightly smaller welfare gain equivalent to 3.49% of consumption and all agents experience a welfare gain. Figure 2.16 plots expected welfare changes over the life cycle in both reform economies relative to the baseline model. Workers experience expected welfare gains at each age independent of Medicaid expansion. Both profiles are increasing over age and peak in the periods prior to mandatory retirement. Workers younger than 35 experience a greater expected welfare gain when Medicaid is expanded. Lower expected welfare gains are experienced by workers older than 35 when Medicaid is expanded compared to the reform that excludes Medicaid expansion.

\(^8\)Let \(EV^B\) and \(EV^R\) denote expected utility for newborns entering the baseline and reform economy, respectively. Then \(CEV = (EV^R/EV^B)^{(1/(1-\sigma))} - 1.\)
### Table 2.5: Bankruptcy Comparison

<table>
<thead>
<tr>
<th></th>
<th>Baseline Economy</th>
<th>Medicaid Expansion</th>
<th>No Medicaid Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bankruptcy Rate</td>
<td>1.11%</td>
<td>0.45%</td>
<td>0.57%</td>
</tr>
<tr>
<td>Medical Bankruptcies</td>
<td>62.17%</td>
<td>5.58%</td>
<td>27.31%</td>
</tr>
<tr>
<td>All Bankruptcies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Divorced</td>
<td>37.71%</td>
<td>97.82%</td>
<td>74.85%</td>
</tr>
<tr>
<td>OOP Med. Spend, Income Ratio</td>
<td>29.40%</td>
<td>4.71%</td>
<td>11.33%</td>
</tr>
<tr>
<td>Percent Below Poverty Level</td>
<td>32.39%</td>
<td>8.63%</td>
<td>28.26%</td>
</tr>
<tr>
<td>Medicaid Categorical Eligible</td>
<td>0.69%</td>
<td>18.33%</td>
<td>3.09%</td>
</tr>
<tr>
<td>Medicaid Medically Needy Eligible</td>
<td>1.14%</td>
<td>0.05%</td>
<td>0.38%</td>
</tr>
<tr>
<td>Insurance Coverage</td>
<td>23.76%</td>
<td>61.43%</td>
<td>69.24%</td>
</tr>
<tr>
<td>Medical Bankruptcies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Divorced</td>
<td>2.51%</td>
<td>72.04%</td>
<td>11.10%</td>
</tr>
<tr>
<td>Percent Below Poverty Level</td>
<td>45.89%</td>
<td>22.94%</td>
<td>84.23%</td>
</tr>
<tr>
<td>Medicaid Categorical Eligible</td>
<td>0.00%</td>
<td>8.52%</td>
<td>0.08%</td>
</tr>
<tr>
<td>Medicaid Medically Needy Eligible</td>
<td>0.14%</td>
<td>0.01%</td>
<td>0.40%</td>
</tr>
<tr>
<td>OOP Med. Spend, Income Ratio</td>
<td>42.95%</td>
<td>24.93%</td>
<td>30.20%</td>
</tr>
<tr>
<td>Insurance Coverage</td>
<td>2.32%</td>
<td>71.36%</td>
<td>16.28%</td>
</tr>
</tbody>
</table>

**Note:** OOP denotes out-of-pocket.

### Bankruptcy Analysis

The results of the previous section suggest that the ACA reforms have a significant effect on bankruptcy decisions. This section further studies the characteristics of defaulters and analyzes the impact of different reform components on bankruptcy rates. Table 2.5 presents bankruptcy statistics in the baseline and reform economies. The bankruptcy rate decreases from 1.11% in the baseline model to 0.45% when the reform includes Medicaid expansion and 0.57% when Medicaid is not expanded. Absent Medicaid expansion, the reforms are able to achieve a large reduction in the percent of medical bankruptcies. Including Medicaid ex-
pansion further reduces the percent of medical bankruptcies to 5.58%.

Among those declaring bankruptcy in the baseline model 37.71% faced divorce expenditure shocks. The percentage of defaulters facing divorce expense shocks increases significantly in both reform economies. Out-of-pocket medical spending averages 29.4% of income for those declaring bankruptcy in the baseline model compared to 4.71% in the reform with Medicaid expansion and 11.33% in the reform that does not expand Medicaid. The reforms also reduce the percentage of defaulters below the poverty level. The portion of agents defaulting with Medicaid categorical eligibility increases under the reforms and to a greater extent when Medicaid is expanded. Few of those declaring bankruptcy are eligible for Medicaid coverage through the medically needy pathway, and the percent of bankruptcies with medically needy coverage decreases under the reforms.

The fraction of medical bankruptcies that are subject to divorce expenses increases under the reforms. The percent of defaulters below the poverty level decreases when the reform includes Medicaid expansion. When Medicaid is not expanded, the majority of medical bankruptcies occur among those with incomes below the poverty level. In the baseline and reform economies few medical bankruptcies occur among those with Medicaid coverage. In the baseline model and reform that excludes Medicaid expansion the majority of medical bankruptcies occur among those without insurance coverage.

Table 2.6 simulates reform economies which exclude certain components of the reform in order to determine their impact on changes in the percent uninsured,
Table 2.6: Reform Contributions to Bankruptcy Changes

<table>
<thead>
<tr>
<th></th>
<th>Percent Uninsured</th>
<th>Bankruptcy Rate</th>
<th>Medical Bankruptcy Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>23.46%</td>
<td>1.11%</td>
<td>62.17%</td>
</tr>
<tr>
<td>Full Reform</td>
<td>7.52%</td>
<td>0.57%</td>
<td>27.31%</td>
</tr>
<tr>
<td>No Mandate Exemptions</td>
<td>4.87%</td>
<td>0.60%</td>
<td>29.63%</td>
</tr>
<tr>
<td>No Cost Sharing Subsidies</td>
<td>10.28%</td>
<td>0.66%</td>
<td>36.87%</td>
</tr>
<tr>
<td>No Community Rating</td>
<td>2.96%</td>
<td>0.56%</td>
<td>26.47%</td>
</tr>
<tr>
<td>No Min. Coverage Requirements</td>
<td>4.79%</td>
<td>0.56%</td>
<td>26.29%</td>
</tr>
<tr>
<td>Extended Subsidies</td>
<td>7.22%</td>
<td>0.52%</td>
<td>19.97%</td>
</tr>
</tbody>
</table>

All reform economies are simulated without Medicaid expansion. “Extended Subsidy’ provides cost sharing subsidies to those with incomes below the poverty level.

Bankruptcy rates and bankruptcies due to adverse medical expenditure shocks. The full reform reduces the percent uninsured, the bankruptcy rate and medical bankruptcies as compared to the baseline model. The individual mandate, which taxes the uninsured, includes exemptions if income is below the poverty level, if premium payments exceed 8% of income or if bankruptcy is declared. Removing all mandate exemptions except in the case of bankruptcy reduces the percent uninsured compared to the full reform. However, the bankruptcy rate and bankruptcies due to medical expenditure shocks increase when the mandate exemptions are removed.

Cost-sharing subsidies limit out-of-pocket expenditures on premiums and medical care for those with income between 100% and 400% of the FPL. Excluding cost-sharing subsidies increases the percent uninsured to 10.28%, increases the bankruptcy rate to 0.66% and increases medical bankruptcies to 29.63%. The community rating provision restricts nongroup insurers from conditioning premi-
ums on health status. Excluding community rating from the reform reduces the percent uninsured to 2.96% and slightly decreases the bankruptcy rate and medical bankruptcies compared to the full reform.

The reform includes minimum coverage requirements for nongroup insurers. Excluding the coverage requirements results in a greater portion of the population covered by insurance and marginally decreases the bankruptcy rate and medical bankruptcy rate compared to the full reform model. Cost-sharing subsidies are not available to those with incomes below the poverty level in the full reform economy. Extending subsidies to those with incomes below the poverty level marginally decreases the percent uninsured. The bankruptcy rate decreases from 0.57% in the full reform model to 0.52% when subsidies are extended and medical bankruptcies decrease from 27.31% to 19.97%.

**Additional Reforms to Medicaid**

As demonstrated in table 2.4 the reform that excludes Medicaid expansion reduced the bankruptcy rate from 1.1% to 0.57% and medical bankruptcies from 62.17% to 27.31%. However, when Medicaid is not expanded those with incomes below the poverty line are not eligible for cost-sharing subsidies. Among those declaring bankruptcy due to medical expenditure shocks the percent below the poverty level increases from 45.89% in the baseline model to 84.23% in the reform that excludes Medicaid expansion, as shown in table 2.5. Additional reforms to Medicaid’s medically needy program provide a means to further reduce medical
### Table 2.7: Medicaid Reform Comparisons

<table>
<thead>
<tr>
<th>Health Insurance Coverage</th>
<th>Baseline Economy</th>
<th>Full Reform</th>
<th>Medicaid Reform 1</th>
<th>Medicaid Reform 2</th>
<th>Medicaid Reform 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Uninsured</strong></td>
<td>23.60%</td>
<td>7.63%</td>
<td>7.04%</td>
<td>7.70%</td>
<td>7.50%</td>
</tr>
<tr>
<td>Group (age &lt; 65)</td>
<td>62.21%</td>
<td>66.93%</td>
<td>67.21%</td>
<td>66.80%</td>
<td>67.05%</td>
</tr>
<tr>
<td>Nongroup (age &lt; 65)</td>
<td>4.56%</td>
<td>19.87%</td>
<td>20.65%</td>
<td>19.79%</td>
<td>20.02%</td>
</tr>
<tr>
<td>Medicaid (age &lt; 65)</td>
<td>2.82%</td>
<td>3.37%</td>
<td>3.06%</td>
<td>3.52%</td>
<td>3.29%</td>
</tr>
<tr>
<td>Percent Medically Needy</td>
<td>33.60%</td>
<td>4.65%</td>
<td>0.00%</td>
<td>12.05%</td>
<td>6.41%</td>
</tr>
<tr>
<td>Medicaid Cost</td>
<td>1.000</td>
<td>0.401</td>
<td>0.316</td>
<td>0.445</td>
<td>0.401</td>
</tr>
<tr>
<td>Bankruptcy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bankruptcy Rate</td>
<td>1.09%</td>
<td>0.57%</td>
<td>0.66%</td>
<td>0.53%</td>
<td>0.57%</td>
</tr>
<tr>
<td>Medical Bankruptcy Rate</td>
<td>61.52%</td>
<td>27.31%</td>
<td>36.61%</td>
<td>21.13%</td>
<td>26.96%</td>
</tr>
</tbody>
</table>

Note: Medicaid Reform 1 - No medically needy for workers; Medicaid Reform 2 - Expansion of medically needy income limit to categorical income limit for all workers; Medicaid reform 3 - Expansion of medically needy income limit to categorical income limit for insured workers. Medicaid cost is relative to the baseline model value.

Removing the medically needy pathway for workers increases insurance coverage which is achieved through higher rates of group and nongroup coverage.

bankruptcies by limiting exposure to large out-of-pocket expenditure shocks. This section examines the impact of additional reforms to Medicaid’s medically needy program on bankruptcy rates and medical bankruptcies.

Table 2.7 compares coverage rates and bankruptcy decisions in the baseline model, the reform without Medicaid expansion, denoted “full reform”, and three additional reforms to Medicaid’s medically needy program. “Medicaid Reform 1” removes the medically needy pathway for workers. “Medicaid Reform 2” expands the medically needy income eligibility limit for all workers to the categorical level, and “Medicaid Reform 3” expands the medically needy income eligibility limit for insured workers to the categorical level.
Expanding the medically needy income limit for all workers slightly increases the percent uninsured compared to the full reform, and expanding the medically needy income limit for only insured workers marginally reduces the percent uninsured. The cost of the Medicaid program decreases by 59.9% in the full reform model, which results from a decrease in medically needy enrollments. Additional reforms to the medically needy program result in Medicaid costs which are below the baseline model.

When the medically needy pathway is eliminated for workers, the bankruptcy rate increases to 0.66% compared to the full reform model. Expanding the medically needy income limit for all workers reduces the bankruptcy rate to 0.53%. When the medically needy income limit is expanded for only insured workers the bankruptcy rate is similar to the full reform model. Removing the medically needy pathway increases medical bankruptcies from 27.31% in the full reform economy to 36.61%. Expanding the medically needy income eligibility limit for all workers or only insured workers decreases the percent of medical bankruptcies as compared to the full reform model.

2.7 Conclusions

A stochastic overlapping generations general equilibrium model with endogenous health insurance and bankruptcy decisions is developed to investigate the impact on insurance coverage and bankruptcy rates of the nongroup insurance reforms of the Patient Protection and Affordable Care Act of 2010. The reforms
include nongroup insurance regulations, an expansion of categorical Medicaid eligibility for workers, cost-sharing subsidies and an individual mandate that taxes the uninsured. The model is calibrated to match key moments observed in the data using estimates from the literature and pooled MEPS and SCF data sets.

The reforms achieve a large reduction in the percent uninsured, with increases in insurance coverage resulting from greater participation in the nongroup insurance market. The bankruptcy rate, and bankruptcies due to medical expenses decrease significantly with the reform. Excluding Medicaid expansion from the reform leads to significant, but more modest reductions in bankruptcies and medical bankruptcies. Cost-sharing subsidies, which limit out-of-pocket expenditures on premiums and medical care contribute greatly to reductions in both bankruptcies and medical bankruptcies. Greater reductions in medical bankruptcies can be achieved if cost-sharing subsidies are extended to those with incomes below the tax filing threshold. In addition to the reduction in medical bankruptcies achieved through the reforms, expanded the income eligibility limit for Medicaid’s medically needy program represents a means of further reducing the incidence of medical bankruptcies among workers.
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nomic Journal: Macroeconomics, 4(3), 96-127

form.” Manuscript, Arizona State University.

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Table 2.8: Data Sample Size

<table>
<thead>
<tr>
<th>Panel</th>
<th>Sample</th>
<th>age &lt; 65</th>
<th>age ≥ 65</th>
</tr>
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<tbody>
<tr>
<td><strong>MEPS Data</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000 - 2001</td>
<td>1,863</td>
<td>1,487</td>
<td>376</td>
</tr>
<tr>
<td>2001 - 2002</td>
<td>4,210</td>
<td>3,423</td>
<td>787</td>
</tr>
<tr>
<td>2002 - 2003</td>
<td>6,146</td>
<td>4,974</td>
<td>1,172</td>
</tr>
<tr>
<td>2003 - 2004</td>
<td>6,223</td>
<td>4,947</td>
<td>1,276</td>
</tr>
<tr>
<td>2004 - 2005</td>
<td>5,940</td>
<td>4,823</td>
<td>1,117</td>
</tr>
<tr>
<td>2005 - 2006</td>
<td>6,036</td>
<td>4,805</td>
<td>1,231</td>
</tr>
<tr>
<td>2006 - 2007</td>
<td>6,514</td>
<td>5,188</td>
<td>1,326</td>
</tr>
<tr>
<td>2007 - 2008</td>
<td>4,966</td>
<td>4,009</td>
<td>957</td>
</tr>
<tr>
<td>2008 - 2009</td>
<td>5,105</td>
<td>4,294</td>
<td>811</td>
</tr>
<tr>
<td>2009 - 2010</td>
<td>3,128</td>
<td>2,567</td>
<td>561</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>50,131</td>
<td>40,517</td>
<td>9,614</td>
</tr>
<tr>
<td><strong>SCF Data</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>20,451</td>
<td>16,733</td>
<td>3,718</td>
</tr>
<tr>
<td>2004</td>
<td>20,953</td>
<td>17,302</td>
<td>3,651</td>
</tr>
<tr>
<td>2007</td>
<td>20,175</td>
<td>16,480</td>
<td>3,695</td>
</tr>
<tr>
<td>2010</td>
<td>29,965</td>
<td>24,855</td>
<td>5,110</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>91,544</td>
<td>75,370</td>
<td>16,174</td>
</tr>
</tbody>
</table>

2.A Data Appendix

2.A.1 Sample Selection

Individuals surveyed for the MEPS are grouped according to Health Insurance Eligibility Units (HIEUs) which are defined as sub-family relationships comprised of adults and insurance eligible family members. The head of the household is not explicitly defined so, following Jeske and Kitao (2009), the head of each HIEU is defined as the person with the highest labor income (using variable wagepY1x and wagepY2x, where Y1 and Y2 denotes the panel year). Those younger than 25 in the first panel year are dropped from the sample as are those older than

2.A.2 Medical Expenditure Shocks

Medical expenditure shocks are estimated from the MEPS panel data using data on total medical expenditures (variables totexpY1 and totexpY2 for panel years 1 and 2) normalized by the sample average income of $33,024. Individuals are sorted into 5 bins depending on where they fall within their age specific spending distribution corresponding to the 50th, 70th, 90th and 99th percentiles. Medical expenditure shocks are calculated as the average medical expenditure within each bin and for each age group.

To calculate medical expenditure shocks for ages not observed in the sample,
and to smooth the medical expenditure shock values over age, a cubic polynomial was fit to each data profile. The fitted polynomial was extended beyond the maximum age observed in the MEPS sample of 85 to estimate shock values. The medical expenditure shock profiles observed in the data and the fitted polynomials are displayed in figure 2.17.

The distribution of medical expenditure shocks is estimated as the fraction of individuals observed in each medical expenditure shock bin conditional on health status. The distribution of medical expenditure shocks by health status is,

\[
f_m(m_j | H_j) = \begin{pmatrix} 0.327 & 0.190 & 0.274 & 0.181 & 0.029 \\ 0.507 & 0.206 & 0.200 & 0.080 & 0.007 \\ 0.588 & 0.195 & 0.161 & 0.053 & 0.004 \\ 0.577 & 0.209 & 0.166 & 0.046 & 0.002 \end{pmatrix}
\]

2.A.3 Productivity Shocks and Group Health Insurance Offer

The productivity process is characterized by a persistent component and an age varying deterministic component that depends on health status. Using labor income (variables wagepY1x and wagepY2x) from the MEPS sample, the deter-
<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.32879</td>
<td>(0.16427)**</td>
</tr>
<tr>
<td>Age</td>
<td>0.04841</td>
<td>(0.00733)***</td>
</tr>
<tr>
<td>Age Squared</td>
<td>-0.00054</td>
<td>(0.00008)***</td>
</tr>
<tr>
<td>Fair Health</td>
<td>-1.11209</td>
<td>(0.20694)***</td>
</tr>
<tr>
<td>Good Health</td>
<td>-1.19515</td>
<td>(0.20070)***</td>
</tr>
<tr>
<td>Excellent Health</td>
<td>-1.37217</td>
<td>(0.19818)***</td>
</tr>
<tr>
<td>Age × Fair Health</td>
<td>0.06527</td>
<td>(0.00940)***</td>
</tr>
<tr>
<td>Age × Good Health</td>
<td>0.07995</td>
<td>(0.00920)***</td>
</tr>
<tr>
<td>Age × Excellent Health</td>
<td>0.09230</td>
<td>(0.00914)***</td>
</tr>
<tr>
<td>Age Squared × Fair Health</td>
<td>-0.00065</td>
<td>(0.00010)***</td>
</tr>
<tr>
<td>Age Squared × Good Health</td>
<td>-0.00082</td>
<td>(0.00010)***</td>
</tr>
<tr>
<td>Age Squared × Excellent Health</td>
<td>-0.00094</td>
<td>(0.00010)***</td>
</tr>
</tbody>
</table>

Significance at the 1% and 5% levels is denoted ** and *, respectively.

The minimistic component is estimated from the regression,

\[
inc = \beta_0 + \beta_1 \text{age} + \beta_2 \text{age}^2 + \beta_3 H + \beta_4 H \times \text{age} + \beta_5 H \times \text{age}^2 + \epsilon
\]

where \(inc\) denotes income normalized by the sample average income and \(H\) denotes health status. OLS estimates are presented in table 2.9. The age profiles conditional on health status, which are displayed in figure 2.6, are calculated using the estimates from table 2.9.

MEPS participants were asked on three separate occasions whether they received an offer to purchase group insurance through the workplace (variables offer31x, offer42x, offer53x). Survey participants are assumed to receive an offer to purchase group health insurance if they answered affirmatively to any of these
three questions. Group insurance offer probabilities, \( f_G(z_j, j) \), are estimated from the MEPS data with a logistic regression,

\[
Pr(i_G = 1|z, j) = \frac{\exp(\beta_0 + \beta_1 j + \beta_2 j^2 + \beta_3 z + \beta_4 z \times j)}{1 + \exp(\beta_0 + \beta_1 j + \beta_2 j^2 + \beta_3 z + \beta_4 z \times j)}
\]

where \( j \) denotes age and \( z \) is the persistent component of labor income, calculated as labor income divided by the health status contingent age component and normalized by a constant so that the average persistent component in the data equals that of the model. The estimated coefficients along with age and the values of the persistent component are used to calculate offer probabilities. The offer probabilities, conditional on age and productivity are displayed in figure 2.18.

2.A.4 Health Insurance

Health insurance coverage is determined using responses to monthly questions for group coverage (pegjaY1-pegdeY1 and pegjaY2-pegdeY2), nongroup cover-
### Table 2.10: Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Full Sample</th>
<th>Uninsured</th>
<th>Privately Insured</th>
<th>Retired</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Size</td>
<td>89,901</td>
<td>28,575</td>
<td>43,099</td>
<td>18,227</td>
</tr>
<tr>
<td><strong>Demographic Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>49.581</td>
<td>41.488</td>
<td>43.829</td>
<td>74.997</td>
</tr>
<tr>
<td>No High School Degree</td>
<td>0.195</td>
<td>0.332</td>
<td>0.092</td>
<td>0.305</td>
</tr>
<tr>
<td></td>
<td>(0.396)</td>
<td>(0.471)</td>
<td>(0.289)</td>
<td>(0.460)</td>
</tr>
<tr>
<td>High School Degree</td>
<td>0.446</td>
<td>0.473</td>
<td>0.425</td>
<td>0.468</td>
</tr>
<tr>
<td></td>
<td>(0.497)</td>
<td>(0.499)</td>
<td>(0.494)</td>
<td>(0.499)</td>
</tr>
<tr>
<td>College Degree</td>
<td>0.360</td>
<td>0.195</td>
<td>0.483</td>
<td>0.228</td>
</tr>
<tr>
<td></td>
<td>(0.480)</td>
<td>(0.396)</td>
<td>(0.500)</td>
<td>(0.419)</td>
</tr>
<tr>
<td>Married</td>
<td>0.435</td>
<td>0.296</td>
<td>0.528</td>
<td>0.353</td>
</tr>
<tr>
<td></td>
<td>(0.496)</td>
<td>(0.456)</td>
<td>(0.499)</td>
<td>(0.478)</td>
</tr>
<tr>
<td>Male</td>
<td>0.498</td>
<td>0.550</td>
<td>0.535</td>
<td>0.332</td>
</tr>
<tr>
<td></td>
<td>(0.500)</td>
<td>(0.497)</td>
<td>(0.499)</td>
<td>(0.471)</td>
</tr>
<tr>
<td><strong>Health Related Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCS Score</td>
<td>49.140</td>
<td>48.982</td>
<td>52.157</td>
<td>41.183</td>
</tr>
<tr>
<td></td>
<td>(10.664)</td>
<td>(10.858)</td>
<td>(8.204)</td>
<td>(12.083)</td>
</tr>
<tr>
<td>Smoker</td>
<td>0.218</td>
<td>0.360</td>
<td>0.196</td>
<td>0.101</td>
</tr>
<tr>
<td></td>
<td>(0.413)</td>
<td>(0.480)</td>
<td>(0.397)</td>
<td>(0.302)</td>
</tr>
<tr>
<td>Emergency Room Visits</td>
<td>0.190</td>
<td>0.241</td>
<td>0.136</td>
<td>0.273</td>
</tr>
<tr>
<td></td>
<td>(0.584)</td>
<td>(0.730)</td>
<td>(0.452)</td>
<td>(0.676)</td>
</tr>
<tr>
<td>Total Medical Spending</td>
<td>$4,346</td>
<td>$2,558</td>
<td>$3,549</td>
<td>$8,683</td>
</tr>
<tr>
<td></td>
<td>($12,015)</td>
<td>($8,279)</td>
<td>($12,104)</td>
<td>($14,377)</td>
</tr>
<tr>
<td>Income</td>
<td>$33,600</td>
<td>$19,009</td>
<td>$49,584</td>
<td>$8,261</td>
</tr>
<tr>
<td></td>
<td>($35,179)</td>
<td>($22,261)</td>
<td>($35,913)</td>
<td>($20,267)</td>
</tr>
</tbody>
</table>

Note: Standard deviations are reported in parentheses. Insured includes those covered by private insurance or Medicare for retirees.

a The Physical Component Summary (PCS) Score is a continuous variable ranging from 0-100 with higher values corresponding to better health.

Age (priaY1-prideY1 and priaY2-prideY2) and Medicaid coverage (mcdjaY1-mcddeY1 and mcdjaY2-mcddeY2). An individual is assumed to be covered by group, nongroup or Medicaid if they were covered under either category for at least 7 months of the year. Medicare coverage is determined using the variables mcrevY1 for panel year 1 and mcrevY2 for panel year 2 which asks whether an
individual was ever covered by public insurance during each panel year.

2.A.5 Health Status Transition Probabilities

Health status transition probabilities are estimated from the 2-year MEPS sample. Health status, which assumes four discrete states, is calculated from the physical component summary score contained in the MEPS. Survey respondents are sorted into four equally sized bins which are labeled poor health, fair health, good health and excellent health. Disabled individuals, identified as those receiving supplemental security income, are excluded from the estimation.

Transition probabilities, which are dependent on current health status, age and insurance coverage, are estimated from the 2-year MEPS panel using a multinomial logit model,

\[
Pr(H_2 = H_j) = \frac{\exp(\beta_{1j} H_1 + \beta_{2j} ins_1 + \beta_{3j} ins_1 \times H_1 + \beta_{4j} ins_1 \times age_1 + \beta_{5j} X_1)}{1 + \sum_{k=1}^{3} \exp(\beta_{1k} H_1 + \beta_{2k} ins_1 + \beta_{3k} ins_1 \times H_1 + \beta_{4k} ins_1 \times age_1 + \beta_{5k} X_1)}
\]

where \( H_2 \) denotes health status in panel year 2, \( H_1 \) is a vector of dummy variables indicating health status in panel year 1, \( ins_1 \) indicates private insurance coverage among those younger than 65 in panel year 1 and \( age_1 \) denotes age in panel year 1. The vector \( X_1 \) contains demographic variables which includes age, age squared, a dummy variable indicating age greater than 65, education, marital status, total medical spending, income, gender, smoking status and the number of emergency
room visits.

Excluding demographic measures from the model might bias the estimated effect of insurance coverage if differences in demographics between the insured and uninsured also influence health outcomes. Table 2.10 presents descriptive statistics for the full sample, the uninsured and privately insured working sample and retirees. Among the working population, the uninsured tend to be younger, less educated, in worse health, more likely to smoke, have lower incomes and spend less on medical care. On average, the uninsured visit the emergency room more frequently as compared to the privately insured. Emergency care represents one of the primary sources of health care for the uninsured (Pitts et al., 2010), and failure to control for this source of care could bias the estimated effect from private insurance on health status.

Table 2.11 presents the estimated coefficients and standard errors from the multinomial logit estimation along with results from likelihood ratio tests which tested the joint significance of the insurance variables. Restricted models were estimated that excluded all insurance variables and only the interaction terms. All insurance variables, and the interaction terms are found to be jointly significant.

Annual transition probabilities, conditional on age health status and insurance coverage, are calculated using the estimates from table 2.11. For retirees, those older than 65, the insurance coverage variables are set to zero and the dummy variable for retirement is set equal to one. Individuals in the sample who are older than 65 and did not report Medicare coverage were dropped. The retirement
Table 2.11: Health Transition Estimation Results

<table>
<thead>
<tr>
<th>Panel Year 2 Health Status</th>
<th>Fair Health</th>
<th>Good Health</th>
<th>Excellent Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.210 (0.196)</td>
<td>-0.421 (0.228)*</td>
<td>-0.352 (0.250)</td>
</tr>
</tbody>
</table>

*Health Variables*

<table>
<thead>
<tr>
<th></th>
<th>Fair Health</th>
<th>Good Health</th>
<th>Excellent Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interceptor</td>
<td>1.708 (0.052)**</td>
<td>2.431 (0.079)**</td>
<td>2.384 (0.097)**</td>
</tr>
<tr>
<td>Fair Health</td>
<td></td>
<td>2.303 (0.076)**</td>
<td>3.879 (0.093)**</td>
</tr>
<tr>
<td>Good Health</td>
<td></td>
<td>2.372 (0.096)**</td>
<td>3.940 (0.107)**</td>
</tr>
<tr>
<td>Excellent Health</td>
<td>-0.141 (0.025)**</td>
<td>-0.213 (0.032)**</td>
<td>-0.318 (0.037)**</td>
</tr>
<tr>
<td>E.R. Visits a</td>
<td>-0.413 (0.057)**</td>
<td>-0.781 (0.088)**</td>
<td>-0.789 (0.100)**</td>
</tr>
</tbody>
</table>

*Demographic Variables*

<table>
<thead>
<tr>
<th></th>
<th>Fair Health</th>
<th>Good Health</th>
<th>Excellent Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retired</td>
<td>0.219 (0.074)**</td>
<td>0.215 (0.039)**</td>
<td>0.276 (0.108)**</td>
</tr>
<tr>
<td>Less Than H.S.</td>
<td>-0.081 (0.033)**</td>
<td>-0.207 (0.043)**</td>
<td>-0.224 (0.047)**</td>
</tr>
<tr>
<td>College Degree</td>
<td>0.066 (0.042)</td>
<td>0.127 (0.046)**</td>
<td>0.419 (0.047)**</td>
</tr>
<tr>
<td>Married</td>
<td>0.101 (0.034)**</td>
<td>0.080 (0.038)**</td>
<td>0.010 (0.040)**</td>
</tr>
<tr>
<td>Income</td>
<td>0.156 (0.025)**</td>
<td>0.245 (0.026)**</td>
<td>0.270 (0.027)**</td>
</tr>
<tr>
<td>Male</td>
<td>0.113 (0.033)**</td>
<td>0.207 (0.037)**</td>
<td>0.124 (0.039)**</td>
</tr>
<tr>
<td>Smoker</td>
<td>-0.162 (0.039)**</td>
<td>-0.226 (0.043)**</td>
<td>-0.416 (0.046)**</td>
</tr>
<tr>
<td>Age</td>
<td>-0.013 (0.008)*</td>
<td>-0.043 (0.009)**</td>
<td>-0.046 (0.010)**</td>
</tr>
<tr>
<td>Age Squared</td>
<td>-1.2e-4 (7.62e-5)</td>
<td>2.79e-5 (9.48e-5)</td>
<td>-8.86e-5 (1.1e-4)</td>
</tr>
</tbody>
</table>

*Insurance Variables (Ins.)*

<table>
<thead>
<tr>
<th></th>
<th>Fair Health</th>
<th>Good Health</th>
<th>Excellent Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insurance Coverage</td>
<td>0.275 (0.129)**</td>
<td>0.677 (0.154)**</td>
<td>0.537 (0.171)**</td>
</tr>
<tr>
<td>Age×Ins.</td>
<td>-0.000 (0.002)</td>
<td>-0.004 (0.002)*</td>
<td>-0.002 (0.003)</td>
</tr>
<tr>
<td>Fair Health×Ins.</td>
<td>-0.069 (0.073)</td>
<td>-0.241 (0.105)**</td>
<td>-0.414 (0.128)**</td>
</tr>
<tr>
<td>Good Health×Ins.</td>
<td>-0.143 (0.103)</td>
<td>-0.252 (0.123)**</td>
<td>-0.359 (0.140)**</td>
</tr>
<tr>
<td>Excellent Health×Ins.</td>
<td>-0.186 (0.130)</td>
<td>-0.279 (0.144)*</td>
<td>-0.250 (0.156)**</td>
</tr>
</tbody>
</table>

*Likelihood Ratio Tests*  

<table>
<thead>
<tr>
<th>D.F.</th>
<th>χ²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint Significance of Insurance Variables</td>
<td>15</td>
</tr>
<tr>
<td>Joint Significance of Insurance Interaction Terms</td>
<td>12</td>
</tr>
</tbody>
</table>

Poor health is the base case. Standard errors are reported in parenthesis. Significance at the 1%, 5% and 10% levels is denoted ***, ** and *, respectively.

*E.R. denotes emergency room.*

dummy variable accounts for any variation in health outcomes among retirees that can be attributed to Medicare insurance coverage. Demographic variables are set equal to their sample averages.

Figure 2.19 plots the ratio of conditional transition probabilities over age for the uninsured relative to the privately insured. Values greater than one indicate a higher probability of transitioning to a certain health state for the uninsured.
Figure 2.19: Transition Probabilities for the Uninsured Relative to the Insured compared to the privately insured. As shown in the upper left plot, the uninsured have a higher probability of transitioning to poor health. With the exception of poor health, the uninsured have a higher probability of transitioning to fair health as shown in the upper right plot. The lower two plots indicate that the uninsured have a lower probability of transitioning to good and excellent health as compared to the privately insured.

2.A.6 Bankruptcy

Estimates of bankruptcy and borrowing are calculated using the pooled SCF data. A survey respondent is categorized as having declared bankruptcy if their reported year of bankruptcy (variable x6774) was within a year of the survey date.
2.B Computational Appendix

The algorithm used to compute the stationary equilibrium is as follows,

1. Discretize the state space for capital into $N_K = 200$ unevenly spaced points $k \in \{k_1, k_2, \ldots, k_{N_K}\}$ where the upper bound on the grid is chosen so that it does not represent a binding constraint on the agent’s problem.

2. Guess initial capital stock, insurance premiums, unintended bequests and cost adjustment factor for firms offering group health insurance and use the firm’s first order conditions to compute factor prices.

3. Solve the agent’s optimization problem recursively for state contingent policy functions.

4. Use the policy functions computed in step (3), the initial distribution of agents ($\lambda_1$) and the transition matrices for productivity, medical expenditure shocks, health status, divorce, credit status and firm type to solve for the distribution of agents through forward simulation.

5. Calculate the updated aggregate capital stock and unintended bequests ($K_1, B_1$) and equilibrium conditions.

6. If the equilibrium conditions and the difference in the initial and updated guess of the capital stock and unintended bequests are satisfied up to a convergence criteria of $\epsilon = 1^{-3}$ then stop; otherwise update insurance premiums, capital stock, unintended bequests, medical sector markup factor...
and the cost adjustment factor and return to step 2 until convergence is achieved.
Chapter 3

A Quantitative Analysis of Medicare Voucher Reforms

3.1 Introduction

Transforming Medicare from its current form into a voucher program, where retirees receive a subsidy to offset the cost of purchasing private insurance, has been proposed as a solution to the program’s budgetary uncertainty. This paper quantitatively studies the impact of Medicare voucher reform proposals on welfare and insurance coverage rates among retirees. A general equilibrium life cycle model is developed which includes stochastic medical expenditure shocks and endogenous health insurance purchase decisions. The model is structured to capture relevant features of the U.S. health care system and the voucher reforms include key features of past legislative proposals.
The model is calibrated to the U.S. economy using data from the Medical Expenditure and Panel Survey 2000-2010 data set. All retired agents are enrolled in the Government’s Medicare insurance program in the baseline model. Under the voucher reforms, retirees may choose between two nongroup policies (which differ in their out-of-pocket spending limit), buying into traditional Medicare, obtaining coverage through their former employer if offered, obtaining coverage through Medicaid subject to a means test, or remaining uninsured. The government is responsible for transferring vouchers to retirees, setting minimum coverage standards for retiree health plans and maintaining traditional Medicare which is no longer subsidized by the Medicare payroll tax.

The model’s health insurance framework is structured to capture key features of the U.S. economy. Workers can purchase health insurance through the nongroup market where premiums are conditioned on health status or obtain employer subsidized and tax preferred group coverage if it is offered through the workplace. Agents who meet the income requirements are eligible for coverage through the Government’s Medicaid program. Retirees matched with a firm offering group insurance in the period prior to retirement may receive an offer to purchase group insurance in retirement to supplement Medicare. Retirees may obtain additional coverage through Medicaid if they qualify.

Model simulations suggest that insurance purchase decisions of retirees are influenced by the incentives provided by the voucher reform. If the voucher can be applied towards premiums and medical care and is transferred unconditionally
then 17.5% of retirees remain uninsured. The percent of retirees uninsured drops to 4.8% when receipt of the voucher is conditional on purchasing health insurance. The presence of Medicaid’s medically needy program provides a form of implicit insurance against large out-of-pocket medical expenses for retirees and reduces savings and insurance purchase incentives. Restricting medically needy eligibility only to insured retirees reduces the percent uninsured to 2.8% among retirees. Retirees who remain uninsured when the voucher and medically needy benefits are received only by those with insurance choose to forgo insurance due to budgetary constraints. Near universal coverage among retirees is achieved by adding a subsidy which restricts spending on traditional Medicare premiums to no more than 30% of income. By comparison, the subsidy provided by the Patient Protection and Affordable Care Act of 2010 restricts spending on insurance premiums to be no greater than 9.5% of income for those with incomes below 400% of the poverty level.

Under the voucher reforms the uninsured tend to be older, have less savings and lower incomes and are in worse health as compared to insured retirees. On average, the net cost of purchasing the least expensive insurance plan varies between 14% and 60% of income for the uninsured, depending on the voucher reform. For insured retirees average net spending on insurance premiums varies between 7% and 14% of income.

Medicare in its current form subsidizes the cost to firms of supplying retirees with supplemental insurance since Medicare insurance is applied first to retirees’
medical spending. Under the voucher reforms, employer provided retiree insurance applies to the full cost of medical expenditures which increases the group premium and the cost to firms that offer insurance to retirees. The increased cost to firms which offer retirees insurance, and higher group premium both adversely impact workers. If firms do not offer retirees insurance in response to the voucher reforms then social insurance spending relative to total Government spending increases relative to the baseline model, under the voucher reform that achieves the highest rate of insurance coverage among retirees. Depending on the structure of the voucher reform, expected welfare gains can be achieved relative to the baseline model for newly born agents and agents entering retirement.

This paper is related to the literature on dynamic stochastic general equilibrium modeling with heterogeneous agents (Bewley, 1986; Imrohoroglu, 1998; Imrohoroglu et al., 1995; Huggett, 1993; Aiyagari, 1994). The model features uninsurable labor productivity risk as in Aiyagari (1994) with the addition of partially insurable medical expenditure risk. Attanasio et al. (2010) use an overlapping generations general equilibrium model with stochastic medical expenditure shocks to study Medicare’s budgetary implications from demographic changes. They find that Medicare is associated with two thirds of the future tax increases required to balance the budget. DeNardi et al. (2010) study the effect that Medicare and Medicaid have on the savings behavior of the elderly and conclude that Medicaid is an important determinant in elderly savings decisions.

This paper is most closely related to Jung and Tran (2009) who use an over-
lapping generations general equilibrium model with endogenous medical spending to study the impact of a voucher reform extended to the entire population. Their model differs importantly from the one considered in this paper in that Medicaid is not explicitly modeled. The presence of Medicaid’s medically needy program, which provides a form of implicit insurance against large medical expense shocks, is found to have a significant impact on the savings and health insurance purchase decisions of retirees in the current model.

The paper is organized as follows: section 2 discusses Medicare voucher reform proposals, section 3 outlines the model economy; section 4 discusses the policy experiment; section 5 outlines the data used in calibration; section 6 discusses parameterization; section 7 presents numerical results and section 8 concludes. Appendix 3.A includes a more detailed discussion of the data used in calibration and appendix 3.B outlines the computational algorithm.

3.2 Medicare Voucher Reform Proposals

Replacing Medicare with a voucher system has frequently been proposed as a means to control Medicare spending growth. Medicare voucher reforms have appeared in the academic literature (for example, Butler and Moffit (1995) and Ginsberg (1981)) and as proposed legislation which includes the National Health Care Reform Act of 1981, the Medicare Preservation and Improvement Act of
2001 and most recently the Rivlin-Ryan Health Care Proposal.\footnote{The Medicare Preservation and Improvement Act of 2001 replaces Medicare with a premium support program which differs from traditional voucher reforms in that the amount received by beneficiaries depends on the weighted average premium of competing health plans (McClellan, 2000).}

Although details differ among each proposal they share many common features. Traditional Medicare will be replaced by a voucher system which entitles eligible recipients to a specified amount that can be applied towards the purchase of health insurance. The value of the voucher is commonly set equal to the average subsidy received by current Medicare recipients. Individuals who purchase insurance that costs more than the voucher amount are responsible for the difference. Certain proposals allow recipients who purchase insurance that costs less than the voucher amount to keep the remainder. The Government transfers vouchers to eligible recipients and sets minimum coverage requirements for insurance plans. Competing health plans must meet the actuarial value of benefits offered by traditional Medicare. Many proposals allow traditional Medicare to continue as an option for eligible recipients to buy into.

Proponents of Medicare voucher reforms argue that introducing competition among health insurers will lead to more efficient delivery of care and that voucher reforms are more fiscally sustainable since the Government’s spending obligations will be limited to voucher payments and not linked to the use of health services by beneficiaries as is the case with traditional Medicare. Little attention has been paid to how a voucher reform would impact coverage rates among retirees and overall social insurance expenditures. Medicaid’s medically needy program pro-
vides a form of implicit insurance against large out-of-pocket expenses for retirees with low savings. Despite the subsidy provided through the voucher, retirees in poor health who do not qualify for Medicaid coverage may be unable to finance the out-of-pocket cost of purchasing insurance if their premium exceeds the voucher amount.

3.3 Model Economy

3.3.1 Demographics

The economy is populated with $J$ overlapping generations, and the population grows at a constant rate $n$. The age $j$ cohort represents a fraction $\mu_j$ of the total population where $\sum_{j=1}^{J} \mu_j = 1$. The exogenous probability of survival between ages $j$ and $j+1$ is given by $\psi_j$ where $\psi_J = 0$ and $0 < \psi_j < 1$ for $j < J$. Thus, the population shares satisfy the recursive relation,

$$\mu_j = \frac{\psi_j}{1+n} \mu_{j-1}$$

Accidental bequests, denoted $B$, left by deceased agents are distributed to surviving and newly born agents in a lump sum manner.
3.3.2 Endowment and Preferences

Labor is supplied inelastically until mandatory retirement beginning in period $j^R$. Agents are heterogeneous in their labor productivity $e_j = \eta_{j,H} \times z_j$ which consists of a persistent stochastic component $z_j$ and a deterministic age varying component $\eta_{j,H}$ which depends on age $j$ and health status $H$. The dependence on health captures differences in income by health status observed in the data and incorporates the empirical finding that better health is associated with higher labor earnings (Currie and Madrian, 1999). The evolution of the persistent process over time is governed by the Markov transition matrix $f_z(z_{j+1}|z_j)$. Gross labor earnings are the product of the equilibrium wage rate and the agent’s productivity, $y_j = w e_j$. In retirement agents receive Social Security benefits $y_j = SS(\bar{y}(z_{j^R - 1}))$ which are a function of the average labor earnings in the period prior to retirement, conditional on $z_{j^R - 1}$.² Ideally, Social Security benefits would depend on the entire earnings history, but doing so greatly increases the computational burden.

Agents have time separable, CRRA preferences over non-medical consumption $c_j$, and seek to maximize the discounted sum of expected utility,

$$ E \left[ \sum_{j=1}^{J} \beta^{j-1} \frac{c_j^{1-\sigma}}{1-\sigma} \right] $$

where $\beta$ is the discount factor and $\sigma$ is the coefficient of relative risk aversion.

²Agents with the same realization of $z_{j^R - 1}$ receive the same Social Security benefits during retirement independent of their health status in period $j^R - 1$. 
3.3.3 Medical Expenditure Shocks, Health Status

Agents differ along two health related dimensions - health status and medical expenditure shocks. Health status $H_j$ is drawn from the finite set $\mathcal{H}$ and evolves over time according to the Markov transition matrix $f_H(H_{j+1}|H_j,j,ins_j)$, which depends on current health status, age and health insurance coverage $ins_j$. Agents face exogenous medical expenditure shocks each period drawn from a finite set $m_j \in \mathcal{M}_j$ which varies with age. The probability of receiving a certain medical expenditure shock is conditional upon the agent’s health status and is given by $f_m(m_j|H_j)$.

3.3.4 Health Insurance

Health insurance coverage, denoted $ins_j$, is endogenous. Workers choose between nongroup insurance ($ins_j = N$), group insurance ($ins_j = G$) if they receive an offer through their employer, remaining uninsured ($ins_j = NI$) or obtaining coverage through Medicaid ($ins_j = MC$) which is means tested. All retirees are enrolled in the Government’s Medicare health insurance program ($ins_j = M$) and may receive additional coverage through Medicaid ($ins_j = MC$) if they qualify or through supplemental group coverage if insurance is offered by their former employer.

Insured agents whose realized medical expenditure shock is $m_j$ face out-of-
pocket expenditures given by,

\[ o(m_j, ins_j) = \min \left\{ m_j, \min \{ \gamma^{ins_j} + \rho^{ins_j}(m_j - \gamma^{ins_j}), M_L^{ins_j} \} \right\} \]

where \( \gamma^{ins_j} \) is the deductible, \( \rho^{ins_j} \) is the coinsurance rate and \( M_L^{ins_j} \) is the out-of-pocket spending limit. Uninsured agents face the full cost of the medical expenditure shock \( m_j \) so that \( o(m_j, NI) = m_j \). Health insurers cover a portion of the medical expenditure shock \( m_j \) given by,

\[ q^{ins_j}(m_j) = m_j - o(m_j, ins_j) \]

The nongroup health insurance market differs from the group health insurance market in a few crucial ways. Health insurance coverage parameters differ between nongroup and group health insurers but are independent of the agents’ medical histories. This assumption implies that agents are not subject to lifetime spending caps by health insurers. Nongroup insurers are able to condition premiums on health status and age which determines the distribution over medical expenditure shocks whereas group health insurers cannot. This assumption follows from the Health Insurance Portability and Accountability Act of 1996 (HIPA) which prohibits discrimination in eligibility, coverage or premiums by group plans based on health factors. A third distinguishing feature of the two health insurance markets is that premiums paid to group insurers are excluded from taxable income. This benefit is not available for those purchasing nongroup insurance.
Private Health Insurance

There are two types of firms in the economy. One type offers group health insurance to its workers whereas the other does not. Let $i_G$ be an indicator function equal to 1 if the firm offers group health insurance and zero otherwise. The probability of being matched with a firm offering group health insurance depends on age and productivity $z_j$ and is given by $f_G(z_j, j)$. Firms offering group health insurance pay a portion $\phi$ of the group health insurance premium and the worker pays the remaining $(1 - \phi)P^G$.

All workers have access to the nongroup health insurance market. Nongroup insurance premiums $P^N_j(H_j)$ are conditioned on health status and age. The health insurance purchase decision is made after the realization of productivity, firm type and health status but before the medical expenditure shock is revealed. Nongroup insurers observe an agent’s age and health status and the conditional distribution over medical expenditure shocks.

Medicare and Supplemental Group Insurance

All retirees are enrolled in the Government’s Medicare health insurance program and pay a premium $P^M$ during each period of retirement. Agents matched with a firm offering group insurance in the period prior to retirement face a fixed probability $\pi$ of being offered group insurance in retirement. Retirees who are offered group insurance pay a premium $(1 - \phi)P^G$ and must continue purchasing group insurance to be eligible to do so in future periods. Coverage under retiree
group insurance applies to out-of-pocket expenditures following Medicare.

**Medicaid Insurance**

Qualified low income agents are eligible for categorical coverage under the Government’s Medicaid health insurance program if their income falls below the threshold $y^{MC}$,

$$y_j + r(k_j + B) < y^{MC}$$

Let $MC^c$ be an indicator function which equals one if the categorical eligibility criteria are satisfied and zero otherwise. Eligibility thresholds differ for workers ($y^{MC}_w$) and retirees ($y^{MC}_r$). Categorical Medicaid coverage is only provided to workers without other forms of insurance or retirees without supplemental Group insurance. Medicaid coverage can also be obtained through the medically needy pathway which allows agents to spend down their assets to a threshold $k^{MC}_{mn}$ provided income falls below the threshold $y^{MC}_{mn}$,

$$y_j + r(k_j + B) - \left(\tilde{o}(m_j, ins_j) - \max(0, k_j + B - k^{MC})\right) < y^{MC}_{mn}$$

where $\tilde{o}(m_j, ins_j)$ denotes out-of-pocket spending before Medicaid coverage applies, which is used to determine medically needy eligibility. Let $MC^{mn}$ be an indicator function which equals one if medically needy eligibility criteria are satisfied and zero otherwise. Out-of-pocket spending for medically needy recipients
is given by,

\[
o(m_j, MC^{mn}) = \min(\hat{o}(m_j, ins_j), \max(0, k_j + B - k_{mn}^{MC})) + o(\max(0, \hat{o}(m_j, ins_j) - \max(0, k_j + B - k_{mn}^{MC})), MC)\]

The function which determines out-of-pocket expenditures for medically needy enrollments applies Medicaid coverage to out-of-pocket expenditures after assets have been spent down to the threshold \(k_{mn}^{MC}\). Medically needy coverage is available to all agents independent of their health insurance status.

### 3.3.5 Health Insurers

Health insurers operate in a competitive environment. Group health insurers charge premiums \(P^G\) and cover a portion \(q^G(m_j)\) of medical expenditures incurred by the agents. Nongroup health insurers charge premiums \(P^N_j(H_j)\) conditional on the agent’s age current health status and cover a portion \(q^N(m_j)\) of medical expenditures in the current period. Premiums adjust to ensure that the zero
expected profit condition holds for both group and nongroup insurers,

\[
P^G = \frac{\omega^G \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) \mathbf{1}_{\{\text{ins}(s_j) = G\}} \left( \sum_{m_j \in M_j} q^G(o(m_j, \text{ins}_j)) f_m(m_j | H_j(s_j)) \right)}{\sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) \mathbf{1}_{\{\text{ins}(s_j) = G\}}} \tag{3.1}
\]

\[
P^N_j(H_j) = \omega^N \sum_{m_j \in M_j} q^N(m_j) f_m(m_j | H_j(s_j)) + \xi, \quad \forall j = 1, \ldots, J^R - 1; \ H_j \in \mathcal{H} \tag{3.2}
\]

where \(\lambda_j(s_j)\) is the measure of age \(j\) agents in state \(s_j \in S_j\). The terms \(\omega^G \geq 1\) and \(\omega^N \geq 1\) denote markup factors for the group and nongroup health insurance markets interpreted as administrative costs, and \(\xi\) is a fixed cost associated with purchasing nongroup insurance. The indicator function \(\mathbf{1}_{\{\text{ins}(s_j) = G\}}\) denotes whether an agent in state \(s_j\) purchases group health insurance in period \(j\). The numerator of equation (3.1) is the expected medical costs covered by the health insurer, and the denominator is the measure of agents who purchase group insurance. Group coverage applies to out-of-pocket expenditures \(o(m_j, \text{ins}_j)\) to account for the assumption that group coverage applies to out-of-pocket expenditures not covered through Medicare among retirees.

### 3.3.6 Firms and Aggregate Production

Firms operate in a perfectly competitive environment and have access to a Cobb-Douglas production technology with constant returns to scale. The aggre-
gate production function is given by,

\[ F(K, L) = AK^\alpha L^{1-\alpha} \]

where \( \alpha \) is capital’s share in production. Capital depreciates at a constant rate \( \delta \) between periods. First order conditions from the firm’s profit maximization problem imply that factor prices satisfy,

\[ r = A\alpha \left( \frac{k}{L} \right)^{\alpha-1} - \delta \]  
\[ w = A(1 - \alpha) \left( \frac{K}{L} \right)^{\alpha} \]  

Aggregate capital and labor efficiency units are given by,

\[ L = \sum_{j=1}^{j^R-1} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) c_j(s_j) \]  
\[ K = \sum_{j=1}^{j} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j)(k_j(s_j) + B) \]  

Firms offering group health insurance pay a portion \( \phi \in [0, 1] \) of the premium. The wage rate paid by firms offering group health insurance adjusts to account for the employer subsidy in order to ensure that the zero profit condition holds. Firms offering group health insurance adjust wages by a factor \( c_G \) which, following
Jeske and Kitao (2009), takes the form,

\[ c_G = \frac{\phi P^G \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j|i_G = 1) \mathbb{1}_{\{\text{ins}_j(s_j) = G\}}}{\sum_{j=1}^{J-1} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j|i_G = 1) e_j(s_j)} \]

The term in the numerator is the measure of agents who purchase group health insurance multiplied by the portion of the insurance premium paid by the employer. The denominator is the total labor supply in efficiency units for working agents who receive a group health insurance offer. The wage rate received by agents matched with a firm offering group health insurance is \( \tilde{w} = w - c_G \), independent of their health insurance purchase decision.

### 3.3.7 Government

The Government taxes economic activity to finance the Medicaid health insurance program, transfers to low income agents and an exogenously given level of consumption \( G \). The Government also runs a balanced budget Social Security system and Medicare health insurance program. The pay-as-you-go Social Security system pays retirees benefits \( SS(\bar{y}(z_{j,R-1})) \), which depend on average labor earnings among agents with common realizations of \( z \) in the period prior to retirement. Social Security is financed by a tax on labor earnings at the rate \( \tau_{SS} \) up to a threshold \( \bar{y} \). The Social Security tax rate adjusts to ensure that the balanced
The budget equation is satisfied,

\[
\sum_{j=1}^{R-1} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) \tau_{SS} \min \{y_j(s_j), \bar{y}\} = \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) SS(\bar{y}(z_{jR-1}))
\] (3.7)

The Government also provides health insurance to retirees through the Medicare health plan. The budget constraint for the Medicare program is given by,

\[
\sum_{j=1}^{R-1} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) q^M(m_j(s_j)) = \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) P^M + \sum_{j=1}^{R-1} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) \tau_{MC} y_j(s_j)
\] (3.8)

where \(\tau_{MC}\) is a payroll tax assessed on working agents which subsidizes the Medicare program. The cost of the Government’s Medicaid program for low income agents is given by,

\[
G^{MC} = \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) \left( MC^c(s_j) q^{MC} \left( o(m_j(s_j), \text{ins}_j(s_j)) \right) + MC^{mn}(s_j) q^{MC} \left( \max(0, \tilde{o}(m_j(s_j), \text{ins}_j(s_j)) - \max(0, k_j(s_j) + B - k_{MC}^{mn})) \right) \right)
\]

The Government taxes economic activity to finance the cost of Medicaid, transfers to low income agents and an exogenous stream of consumption \(G\). Consumption is taxed at a linear rate \(\tau_c\), labor and capital income are taxed according to the function \(T_y(\tilde{y})\) where \(\tilde{y}\) denotes taxable income defined as income less contributions to the Social Security and Medicare programs, premiums paid to group health insurers, and out-of-pocket medical expenses which exceed 7.5% of income.
The Government is not allowed to borrow and runs a balanced budget each period,

\[ G + G^{MC} + \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) Tr(s_j) = \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) \left[ T_y(\tilde{y}(s_j)) + \tau_c c_j(s_j) \right] \]

(3.9)

where \( Tr(s_j) \) denotes transfers to agents in state \( s_j \). The Government is responsible for distributing unintended bequests which are given by,

\[ B = \sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j (1 - \psi_j) \lambda_j(s_j) k_{j+1}(s_j) \]

(3.10)

A safety net is provided to all agents in the form of a guaranteed consumption floor, \( c \). The consumption floor is intended to stand in for transfer programs such as TANF and food stamps for low income earners. Social insurance transfers, which are made net of out-of-pocket medical expenditures and the mandatory Medicare premium for retirees, take the form,

\[ Tr = \max \left\{ 0, c + P^M_1 \{ j \geq j \} + o(m_j, ins_j) - (y_j + (1 + r)(k_j + B) - T_y(\tilde{y}_j)) \right\} \]

where \( 1_{(j \geq j \{ \})} \) is an indicator function equal to one if the agent is retired.

3.3.8 The Agent’s Problem

The period \( j \) state space \( S_j \) which summarizes an agent’s status in the model consists of a level of savings \( k_j \in \mathbb{R}_+ \), health status \( H_j \in \mathcal{H} \), medical spend-
Figure 3.1: Within Period Timing of Events

ing shock $m_j \in M_j$, productivity parameter $e_j$ and firm type $i_G$ indicating the availability of group insurance. The timing of events, depicted in figure 3.1, is as follows: agents enter each period with savings $k_j$ and learn realizations of their health status $H_j$, productivity parameter $e_j$ and firm type $i_G$. They work and commit to a health insurance arrangement. Agents then learn the realization of their medical expenditure shock, receive transfers from the Government, pay out-of-pocket medical expenses and premiums (if applicable) and make consumption and savings decisions.

Agents make saving, consumption and health insurance purchase decisions to maximize expected lifetime utility. The agent’s optimization problem is written
V_j(s_j) = \max_{c_j,k_{j+1},\text{ins}_j} \left\{ \frac{c_j^{1-\sigma}}{1-\sigma} + \beta E_j[V_{j+1}(s_{j+1})] \right\}

s.t.

\begin{align*}
(1 + \tau_c)c_j + o(m_j,\text{ins}_j) + k_{j+1} + P^{\text{ins}_j} &= y_j + (1 + r)(k_j + B) + Tr - Tax \\
y_j &= \begin{cases} 
(w - c_G \times i_G)e_j & j < j^R \\
SS(\tilde{y}(z_{j,R-1})) & j \geq j^R
\end{cases}
\end{align*}

Expectation is taken over future labor productivity, medical expenditures, health status, demographic characteristics and firm type. Tax payments are given by,

\begin{align*}
Tax &= \begin{cases} 
\tau_{SS}\min\{y_j, \tilde{y}\} + \tau_{MC}y_j + T_y(\tilde{y}_j) & j < j^R \\
T_y(\tilde{y}_j) & j \geq j^R
\end{cases}
\end{align*}

where \(\tilde{y}_j\) is taxable income. For workers \(\tilde{y}_j\) is defined as labor and capital income less Social Security and Medicare payroll taxes, premium payments to group insurers and medical expenditures which exceed 7.5% of income. For retirees, \(\tilde{y}_j\) is defined as capital income less medical expenditures in excess of 7.5% of income.

Premium payments for health insurance, \(P^{\text{ins}_j}\), are given by \((1 - \phi)P^G\) if the agent purchases group health insurance, \(P^N_j(H_j)\) for an age \(j\) agent with health status \(H_j\) purchasing nongroup insurance, \(P^M\) for Medicare eligible retirees, \(P^M + (1 - \phi)P^G\) for retirees purchasing supplemental group insurance and
zero if the agent has no health insurance or Medicaid only.

During an agent’s working life, the decision to purchase health insurance is made by comparing expected utilities under each insurance arrangement before the medical expenditure shock has been realized. An agent decides to purchase health insurance if the expected utility from a given insurance arrangement exceeds the expected utility from other insurance options.

### 3.3.9 Stationary Competitive Equilibrium

All agents enter the economy with zero savings. The state space is defined by age $j = 1, \ldots, J$, productivity $e_j$, medical spending shock $m_j \in M_j$, health status $H_j \in \mathcal{H}$, saving $k_j \in \mathbb{R}_+$ and firm type $i_G$ indicating whether group health insurance may be purchased.

Given the exogenous probability of survival $\{\psi_j\}_{j=1}^J$, transition probabilities $\{f_z, f_m, f_H, f_G, \pi\}$ and initial distribution $\lambda_1$ a stationary competitive equilibrium is a sequence of state contingent decision plans for the agent $\{c_j(s_j), k_{j+1}(s_j), ins_j(s_j)\}_{j=1}^J$, production plans for the firm $\{K, L\}$, insurance premiums $\{P^G, P^N_j(H_j), P^M\}$, unintended bequests $B$, social security benefits $SS(y_{j-1})$, taxes $\{\tau_{SS}, \tau_{MC}, \tau_c, T_y(\tilde{y})\}$ and factor prices $\{w, r\}$ such that

1. The private insurer’s budget constraints (3.1) and (3.2) hold.

2. Factor prices satisfy the firm’s first order conditions (3.3) and (3.4).

3. Markets clear so that (3.5) and (3.6) hold.
4. The Social Security and Medicare programs are self-financing so that (3.7) and (3.8) hold.

5. The Government’s budget balances (3.9) and unintended bequests satisfy equation (3.10).

6. Given prices, Government policy, transfers and initial conditions the state contingent decision plans solves the agent’s problem (3.11).

7. The economy’s aggregate resource constraint holds,

\[ G + C + K' + M + X = AK^\alpha L^{1-\alpha} + (1 - \delta)K \]

where \( X \) denotes administrative spending on health insurance and,

\[ C = \sum_{j=1}^{J} \sum_{s_j \in \mathcal{S}_j} \mu_j \lambda_j(s_j) c_j(s_j), \]
\[ K' = \sum_{j=1}^{J} \sum_{s_j \in \mathcal{S}_j} \mu_j \lambda_j(s_j) k_{j+1}(s_j) \]
\[ M = \sum_{j=1}^{J} \sum_{s_j \in \mathcal{S}_j} \mu_j \lambda_j(s_j) m_j(s_j) \]
\[ X = \sum_{j=1}^{J} \sum_{s_j \in \mathcal{S}_j} \mu_j \lambda_j(s_j) \left( m_j(s_j) \omega^G 1_{\{\text{ins}_{j}(s_j) = G\}} + (\xi + m_j(s_j) \omega^N) 1_{\{\text{ins}_{j}(s_j) = N\}} \right) \]

8. the distribution of agents over the state space satisfies \( \lambda_{j+1} = \Lambda(\lambda_j) \), where \( \Lambda(\cdot) \) is a one-period transition operator on the agent distribution.
3.4 Policy Experiment

Under the policy experiment retirees receive a voucher which can be applied towards medical spending or insurance premiums. The voucher program is financed by the Medicare payroll tax. Insurance choices available to retirees under the voucher reform are modeled to capture many of the features described in section 2. Traditional Medicare remains as a community rated option for retirees and the premium is determined from the zero profit condition,

\[
P_m = \frac{\sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) 1_{\{ins_j(s_j) = M\}} q^M(m_j(s_j))}{\sum_{j=1}^{J} \sum_{s_j \in S_j} \mu_j \lambda_j(s_j) 1_{\{ins_j(s_j) = M\}}} \tag{3.12}
\]

Traditional Medicare is no longer subsidized through the Medicare payroll tax and retirees who purchase traditional Medicare must pay the full premium. Unlike private insurers, the zero profit condition for traditional Medicare does not include a markup factor which reflects Medicare’s relatively low administrative costs. Retirees may purchase group insurance if it was offered through their former employer. Under the voucher reform, group insurance applies to the full cost of retiree’s medical spending. Two nongroup insurance contracts are available to retirees which differ only in the out-of-pocket spending limit. Nongroup premiums are conditioned on the agent’s health status in each period. Finally, low income retirees may be eligible for coverage under Medicaid.

Retired agents will receive a credit equal to the average subsidy received by

\footnote{Administrative expenses accounted for 1.5% of total expenditures in 2007 according to the 2008 Medicare Trustees Report.}
retirees as part of Medicare where revenues are collected from the Medicare payroll tax. This subsidy can be used to offset the cost of purchasing health insurance through the nongroup or group market or used to self-insure but the voucher may only be applied to medical care and health insurance premiums. Under the Government’s Medicare voucher program, the retired agent’s budget constraint becomes,

\[(1 + \tau_C)c_j + o(m_j, ins_j) + k_{j+1} + P^{ins_j} = SS_b(\bar{y}(z_{j,n-1}))\]

\[+ Tr + \min\{S_j, o(m_j, ins_j) + P^{ins_j}\} + (1 + r)(k_j + B) - T_y(\tilde{y}_j)\]

where \(S_j\) denotes the voucher subsidy received by retired agents.

### 3.5 The Medical Expenditure Panel Survey

Unless otherwise specified, the model is calibrated using data from the Medical Expenditure Panel Survey (MEPS). The MEPS consists of a series of two-year panel surveys administered by the Agency for Health Care Research and Quality to a nationally representative sample of employers, families and their medical providers. The analysis uses 10 panels from 2000/2001 to 2009/2010 consisting of 50,131 individuals.

The household component of the MEPS data contains information on wage earnings, medical spending and insurance status. Income is normalized to a base year of 2007 using the Consumer Price Index (CPI). Medical spending is normal-
ized to a base year of 2007 using the CPI for medical care. Survey participants are grouped into Health Insurance Eligibility Units (HIEU) which includes family members who are eligible to receive coverage under their family’s health insurance plan. HIEU’s include adults, their spouses, children under the age of 18 and children under 24 who are full time students. Data is used for the head of each household only. The MEPS data does not explicitly identify heads of household so, following Jeske and Kitao (2009), the household head for married couples is identified as the person with the highest income within each HIEU. A more detailed description of the data and calibration is provided in Appendix 3.A.

3.6 Parameterization

3.6.1 Demographics

Agents enter the model at age 25 with zero assets and death occurs with certainty at age 101. Each model period equates to one year so that $J = 76$ and retirement begins at age 65 so that $j^R = 41$. The population growth rate is 1.2% which is the average growth rate for the U.S. population from 1950 to 2007 according to the U.S. Census. The survival probabilities $\{\psi_j\}_{j=1}^J$, displayed in figure 3.2, are taken from the 2007 U.S. Actuarial Life Tables.
3.6.2 Medical Expenditure Shocks, Health Status

Health status is discretized into 4 states using the Physical Component Summary (PCS) score from the MEPS sample. The PCS is a continuous variable computed from 12 survey questions related to an individual’s general health, physical limitations and mental health state. Higher PCS scores correspond to better health. The algorithm used to create the PCS score is described in Ware et al. (1996).

MEPS sample respondents are sorted into four equally sized groups based on their PCS score. The four states are labeled poor health, fair health, good health and excellent health. Health status transition probabilities, \( f_{H_j}(H_{j+1}|H_j, j, ins_j) \), are estimated from the 2-year MEPS sample using a multinomial logit model which controls for demographic measures, age and a binary indicator for health insurance coverage. Disabled individuals, identified as those receiving supplemental security income, are excluded from the estimation. The health insurance coverage indicator equals one for workers covered by private insurance and zero otherwise. Health
transition probabilities are equal for the uninsured or those covered by Medicaid only. Relative to those with private insurance coverage, Medicaid patients are less likely to receive certain diagnostic procedures (Horner et al., 1995), more likely to face difficulty in obtaining services (Berk and Schur, 1998) and more likely to experience worse health outcomes relative to those with private insurance (Ayanian et al., 1993; Roetzheim et al., 2000; Braveman et al., 1994). These empirical findings are reflected in the estimation strategy.

The initial distribution over health states is a weighted average of the invariant distributions associated with the Markov transition matrices of the uninsured and insured in the initial period, weighted by the fraction of 25 year old MEPS survey participants with private insurance coverage. The health status profiles over the life cycle are presented in figure 3.4. Realizations of health status over the life cycle are influenced by health insurance decisions. The model closely replicates the age profiles of each health status.

Medical expenditure shocks are estimated from each individual’s annual total health care expenditures as reported in the MEPS sample using a method similar to Jeske and Kitao (2009), Imrohoroglu and Kitao (2012) and Pashchenko and Porapakkarm (2013). Individuals within the sample are sorted into 5 groups depending on where they fall within their age specific spending distribution corresponding to the 50th, 70th, 90th and 99th percentiles.

Medical expenditure shocks are estimated as the mean spending level within each age group, normalized by the sample average labor income of $33,024. Since
the MEPS data only observes individuals up to age 85, a cubic polynomial is fit to each medical expenditure shock profile to smooth the profile and estimate shock values for ages 86 to 100. Medical expenditure shock age profiles and the fitted data profiles are provided in the appendix. The average medical spending age profiles produced by the model and observed in the MEPS sample are plotted in figure 3.3. The distribution of medical expenditure shocks, $f_m(m_j|H_j)$ is estimated as the fraction of the population within each of the 5 medical expenditure shock bins conditional on health status. The medical expenditure shock distribution conditional on health status is provided in the appendix.

The MEPS data, which consists of individual survey responses, underestimates
aggregate medical expenditures compared to the National Health Expenditure Accounts (NHEA), which are based on provider revenue data. Sing et al. (2006) finds that the 2002 MEPS underestimates total medical expenditures by 13.8% compared to the NHEA. As discussed in Attanasio et al. (2011), the NHEA data are derived from provider surveys whereas the MEPS collects data from household surveys, which tend to under report spending and utilization. Following Attanasio et al. (2011), medical expenditure shocks estimated from the MEPS are scaled by a factor of 1.231 to match the aggregate medical spending to GDP ratio of 15.85%, which is the average medical spending to GDP ratio from 2000-2010 according to the NHEA.

### 3.6.3 Endowment and Preferences

The coefficient of relative risk aversion $\sigma$ is set equal to 2 and the discount factor $\beta = 0.994183$ is calibrated so that the model produces a capital-output ratio of 3. The working agent’s labor endowment is characterized by a deterministic age
component $\eta_{j,H}$ and a persistent component $z_j$. The deterministic age profiles are estimated from the regression,

$$\text{inc} = \beta_0 + \beta_1 \text{age} + \beta_2 \text{age}^2 + \beta_3 H + \beta_4 H \times \text{age} + \beta_5 H \times \text{age}^2 + \epsilon$$

where $\text{inc}$ is labor income normalized by the sample average labor income, $H$ denotes health status and $\epsilon$ is the error term. The age profiles produced from the estimates are presented in figure 3.5. Each profile is slightly hump shaped and peaks near age 50. Conditional on age, better health results in higher values of $\eta_{j,H}$ which translates into higher labor earnings. Variation in the health dependent term accounts for 8.78% of the variation in log earnings in the baseline model.

The persistent process is given by $z_j = \exp(\nu_j)$ where $\nu_j$ evolves according to,

$$\nu_{j+1} = \rho_z \nu_j + \epsilon_j, \quad \epsilon_j \sim N(0, \sigma^2_\epsilon)$$

The persistent process is discretized into 7 equally spaced points ranging from $-2\sigma^2_z$ to $2\sigma^2_z$ using Tauchen’s (1986) method. The parameters governing the persistent process $\rho_z = 0.984$ and $\sigma^2_\epsilon = 0.022$ are taken from Storesletten et al. (2004). Realizations of $z_j$ in the initial period are drawn from the distribution $N(0, 0.2704)$, where the variance is calibrated to match variance of log earnings among 25 year olds of 0.323, according to Storesletten et al. (2004).
3.6.4 Health Insurance

The markup factors on private health insurance $\omega^G$ and $\omega^N$ are set equal to 1.11 following Kahn et al. (2005). The fixed cost associated with purchasing nongroup insurance $\xi = $347 is calibrated to match the takeup ratio of nongroup insurance among individuals younger than 65 observed in the MEPS sample. The two nongroup insurance parameters $\omega^N$ and $\xi$ imply that average administrative spending by nongroup insurers is 23.57% in the model compared to the estimated average of 30% according to Pauly and Nichols (2002) and Pauly et al. (1999).

The probability of being matched with a firm offering group insurance $f_G(z_j, j)$ is estimated from the logistic regression,

$$Pr(i_G = 1|z, j) = \frac{\exp(\beta_0 + \beta_1 j + \beta_2 j^2 + \beta_3 z + \beta_4 z \times j)}{1 + \exp(\beta_0 + \beta_1 j + \beta_2 j^2 + \beta_3 z + \beta_4 z \times j)}$$

where $j$ denotes age and $z$ is the persistent component of labor income. In the data the persistent component is calculated as labor income divided by the health status dependent age component, and normalized by a constant so that the average persistent component in the data equals that of the model. The group insurance offer age profiles produced by the model and observed in the data are depicted in figure 3.6. The portion of the group premium paid by the employer, $\phi = 0.77132$ is calibrated to match the group insurance take up ratio produced by the model and observed in the data. The probability of receiving an offer to purchase group insurance in retirement, conditional on a group insurance offer in period $j^R - 1$,
\[ \pi = 0.508 \] is chosen to match the group insurance coverage rate among retirees.

The parameters which govern the generosity of insurance coverage include the deductible \( \gamma^{ins}_j \), coinsurance rate \( \rho^{ins}_j \) and the out-of-pocket spending limit \( M^{ins}_L \). All nominal variables are normalized by the MEPS sample average income. The deductible and out-of-pocket spending limit for group health insurance are set to \( \gamma^G = 1,040 \) and \( M^G_L = 2,648 \) following Claxton et al. (2012). The coinsurance rate is set to \( \rho^G = 18.5\% \) following Sommers and Crimmel (2008).

Nongroup insurance parameters are taken from a comprehensive survey of nongroup health insurers (America’s Health Insurance Plan, 2009). Parameter values correspond to the reported averages for Preferred Provider Organization family plans. The nongroup deductible is set to \( \gamma^N = 5,514 \) and the coinsurance rate is \( \rho^N = 25.7\% \). The out-of-pocket spending limit for nongroup insurance is \( M^N_L = 9,290 \).

The Medicare deductible is set to \( \gamma^M = 147 \) and the coinsurance rate \( \rho^M = 20\% \) which are taken directly from the Medicare Part B cost-sharing structure.\(^4\) Medicare does not provide protection against large out-of-pocket expenditure risk (Goldman and Zissimopoulos, 2003; Rapaport, 2009) and so no out-of-pocket spending limit is set for Medicare.

Medicaid’s cost-sharing structure varies by income but generally features a nominal deductible, low coinsurance rate and a low out-of-pocket maximum.\(^5\) The

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\(^4\)For more information see [http://www.medicare.gov/your-medicare-costs/](http://www.medicare.gov/your-medicare-costs/)

Medicaid deductible is set to $\gamma^{MC} = 0$, the coinsurance rate is set to $\rho^{MC} = 10\%$ and the out-of-pocket maximum is set to $M^{MC}_L = 5\% \times FPL$ where FPL is the Federal Poverty Level.

### 3.6.5 Market Production

The Cobb-Douglas technology available for production is $F(K, L) = AK^\alpha L^{1-\alpha}$. The value of $\alpha$ determines capitals share in production and is set equal to 0.33. The annual capital depreciation rate is set to 6%. Total factor productivity $A = 0.68575$ is set such that the average labor income equals one when the capital output ratio is 3. Given individual behavior, the wage rate and interest rate are determined in general equilibrium from the firm’s profit maximizing first order conditions, equations (3.3) and (3.4).

### 3.6.6 Government

Government spending $G$ is chosen so that it accounts for 18% of aggregate output following Jeske and Kitao (2009). The consumption floor is set to $2,700 (in 1998 dollars) following De Nardi et al. (2010). The Federal Poverty Level (FPL) is set to $10,210 which is the 2007 poverty level for a single person.

Medicaid’s income eligibility threshold in the benchmark model is set equal to $y^{MC}_r = 0.64 \times FPL$ for retirees to minimize the difference between Medicaid coverage rates among retirees observed in the MEPS sample and those produced by the model. Similarly, the categorical eligibility limit for workers is $y^{MC}_w = 0.67 \times FPL$ which is chosen to match the Medicaid coverage rate among non-disabled working adults in the MEPS data. The medically needy eligibility threshold is set equal
to $y_{mn}^{MC} = 0.32 \times FPL$ and the asset limit is $k_{mn}^{MC} = $2,704 (Kaiser Family Foundation, 2012).

The Government runs a Social Security system financed by a tax on labor income $\tau_{SS}$ which adjusts to ensure the program is budget balanced. Social Security taxes are applied to gross labor earnings up to the threshold $\bar{y} = $97,500, which is taken from the 2007 Social Security Trustees report. The piecewise linear function which determines Social Security benefits depends upon labor earnings in the period prior to retirement and features three bend points. The formula is taken from the 2007 Social Security Trustees report. Cutoff values are normalized by the MEPS sample average income.

$$SS(y_{jR}^{n-1}) = \begin{cases} 
0.90 \times y_{jR}^{n-1} & y_{jR}^{n-1} < $8,160 \\
$7,344 + 0.32 \times (y_{jR}^{n-1} - $8,160) & $8,160 \leq y_{jR}^{n-1} < $49,200 \\
$20,477 + 0.15 \times (\min\{\bar{y}_{SS}, y_{jR}^{n-1}\} - $49,200) & y_{jR}^{n-1} \geq $49,200
\end{cases}$$

where $\bar{y}_{SS} = $81,968 which equates to the maximum allowable benefit level of $2,116 per month in 2007.

According to the 2008 Medicare Trustees Report, 12% of the program’s revenue was generated from premiums, which is the fraction used in the model to determine the Medicare premium. The Medicare payroll tax $\tau_{MC}$ adjusts to ensure the program’s budget balances.

The proportional tax on consumption $\tau_c$ is equal to 5.67% following Mendoza et al. (1994). The income tax function consists of a non-linear progressive term and a proportion term. The progressive tax function, taken from Gouveia and Strauss (1994), approximates the U.S. income tax code. The proportional term
accounts for additional non-income or consumption related taxes. The individual tax function is given by,

\[ T_y(\bar{y}) = a_0 \left[ \bar{y} - (\bar{y}^{-a_1} + a_2)^{-1/a_1} \right] + \tau_y \bar{y} \]

This functional form has been used in the public finance literature by Conesa and Krueger (2006), Conesa et al. (2009) and Jeske and Kitao (2009) among others. The parameter \( a_0 \) determines the level of the average tax rate and \( a_1 \) controls the progressivity of the tax code. Gouveia and Strauss (1994) find that the values \( a_0 = 0.258 \) and \( a_1 = 0.768 \) best approximate the actual U.S. income tax code and are the values used in the benchmark analysis. The parameter \( a_2 = 1.575 \) adjusts so that revenue generated from the progressive term in the income tax function accounts for 65% of Government revenue. The proportional term \( \tau_y = 0.078 \) adjusts to ensure the Government’s budget balances.

### 3.6.7 Policy Experiment

Under the Medicare voucher program, the Government transfers revenue generated from the Medicare payroll tax to retirees in lump sum form. Retirees can purchase traditional Medicare where the premium is determined by the zero profit condition (3.12), group coverage if their former employer offers insurance during retirement or two separate nongroup policies. Generally, minimum coverage requirements in voucher reform proposals require policies to meet the actuarial value.
of traditional Medicare benefits. Both nongroup policies deductible and coinsurance rates are equal to those of traditional Medicare. One nongroup policy, termed “No Spending Limit”, has no out-of-pocket spending limit similar to traditional Medicare. The other nongroup policy, termed “Spending Limit”, sets an out-of-pocket spending limit of $2,000 which is the out-of-pocket limit proposed for high option Medicare plans in the Medicare Preservation and Improvement Act of 2001.

The Medicare voucher amount is set equal to the average subsidy received by retirees in the baseline model through the Medicare payroll tax. Under the reform, the Medicare payroll tax $\tau_{MC}$ adjusts so that the voucher program is self-financing.

### 3.7 Numerical Results

#### 3.7.1 Benchmark Model

Table 3.1 presents relevant statistics produced by the model and their counterparts observed in the data. Unless otherwise specified model targets and age profiles are calculated from the MEPS data discussed in section 5. The model produces a medical spending to GDP ratio of 15.85% which matches the ratio observed in the National Health Expenditure Accounts (NHEA). Medical spending by health insurers accounts for 74% of all medical spending in the model, compared with 74.40% according to NHEA (2007). Relative to average income, the average nongroup premium is 10.33% in the model compared to 15.68% according to America’s Health Insurance Plan (2009). The group premium is 9.26% of
Table 3.1: Benchmark Model Fit

<table>
<thead>
<tr>
<th></th>
<th>Model</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical Spending to GDP Ratio</td>
<td>15.85%</td>
<td>15.85%a</td>
</tr>
<tr>
<td>Medical Spending Covered by Insurance</td>
<td>74.00%</td>
<td>74.17%a</td>
</tr>
<tr>
<td>Avg. Nongroup Premium to Avg. Income Ratio</td>
<td>10.33%b</td>
<td>15.68%b</td>
</tr>
<tr>
<td>Group Premium to Average Income Ratio</td>
<td>9.26%</td>
<td>10.47%</td>
</tr>
<tr>
<td>Average Saving Rate</td>
<td>6.03%</td>
<td>5.35%c</td>
</tr>
<tr>
<td>Earnings Gini Coefficient</td>
<td>0.528</td>
<td>0.636d</td>
</tr>
<tr>
<td>Wealth Gini Coefficient</td>
<td>0.718</td>
<td>0.816d</td>
</tr>
<tr>
<td><strong>Medicaid Coverage</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Population</td>
<td>6.07%</td>
<td>5.67%</td>
</tr>
<tr>
<td>Percent Medically Needy Enrollments</td>
<td>26.40%</td>
<td>17.80%c</td>
</tr>
<tr>
<td><strong>Health Insurance Coverage (Workers)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medicaid Coverage</td>
<td>3.97%</td>
<td>3.96%</td>
</tr>
<tr>
<td>Nongroup Coverage</td>
<td>4.58%</td>
<td>4.57%</td>
</tr>
<tr>
<td>Group Coverage</td>
<td>62.32%</td>
<td>62.33%</td>
</tr>
<tr>
<td>Group Insurance Takeup Rate</td>
<td>92.22%</td>
<td>90.83%</td>
</tr>
<tr>
<td><strong>Health Insurance Coverage (Retirees)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medicaid Coverage</td>
<td>13.37%</td>
<td>12.53%</td>
</tr>
<tr>
<td>Supplemental Group Coverage</td>
<td>29.57%</td>
<td>29.58%</td>
</tr>
</tbody>
</table>

a Source: 2000-2010 National Health Expenditure Accounts (NHEA)
b Source: Average nongroup premium for family coverage (America’s Health Insurance Plan, 2009)
c Source: 2000-2010 Flow of Funds Accounts
d Source: Díaz-Giménez et al. (2011)
e Source: 2000-2009 Medicaid Statistical Information System. Ratio is medically needy enrollments to adults and participants age 65 and older.

The average saving rate in the model is 6.07% compared to 5.35% in the 2000-2010 Flow of Funds Accounts. Wealth and earnings are less concentrated in the model as compared to estimates by Díaz-Giménez et al. (2011). Heterogeneity in productivity is limited within the model. Agents do not differ in ways that may reflect differences in human capital, nor is unemployment included in the
model which may partially explain the difference in earnings concentration. The earnings concentration in part explains the inability of the model to match the wealth concentration observed in the data. Additionally, features important to explaining the wealth distribution such as bequest motives and entrepreneurship (Cagetti and DeNardi, 2008) are not modeled.

Medicaid coverage in the model is 6.07% compared with 5.67% in the MEPS data. Medically needy enrollments account for 26.4% of Medicaid enrollments in the model compared to 17.8% according to the 2000-2009 Medicaid Statistical Information Tables. The model successfully matches the Medicaid, nongroup and group insurance coverage rates among workers observed in the MEPS data. The group insurance takeup rate, defined as the percentage of those purchasing group insurance conditional on an offer, is 92.22% in the model compared to 90.83% in the MEPS data. The model over predicts Medicaid coverage among retirees. In the model 13.37% of retirees are covered by Medicaid compared to 12.53% in the MEPS data. Supplemental group coverage among retirees is identical between the model and the MEPS sample.

Figure 3.7 plots group coverage among retirees over age. The group coverage profile among retirees is decreasing in the MEPS sample whereas the model profile is relatively flat. Figure 3.8 plots the Medicaid coverage profile observed in the data and produced by the model. The model profile includes both categorical and medically needy participants. The model slightly under predicts Medicaid coverage among workers younger than 45 and over states coverage among workers
older than 45. The coverage profile among retirees is similar between the MEPS sample and the model. Figure 3.9 plots group and nongroup coverage profiles for workers observed in the data and produced by the model. Both group and nongroup coverage profiles are similar between the model and the MEPS data.

3.7.2 Medicare Voucher Reform

Steady State Comparison

Under the policy experiment, the Government institutes a voucher program for retirees by eliminating the Medicare health insurance program and transferring
revenue collected from the Medicare payroll tax in lump-sum form to retirees. The voucher amount equals $9,583, which is the average subsidy received by retirees through the Medicare payroll tax in the baseline model. All model parameters discussed in the parameterization and calibration sections remain unchanged in the reform economy. The proportional term in the income tax function $\tau_y$ adjusts to ensure that the Government’s budget balances in the reform economy.

Table 3.2 compares steady states in the the baseline and reform economies under four variants of the Medicare voucher program. In all reform economies the voucher may be applied towards medical expenditures and insurance premiums. All retirees in “Voucher Reform 1” receive a voucher. Retirees in the “Voucher Reform 2” economy receive the voucher only if insurance is purchased. Under “Voucher Reform 3”, insurance coverage is a condition for receipt of the voucher and an eligibility requirement for Medicaid’s medically needy program. “Voucher Reform 4” contains the same conditions as “Voucher Reform 3” as well as a subsidy that limits out-of-pocket spending on traditional Medicare premiums to 30% of income.

Each voucher reform produces a large increase in the group premium, which varies between 61.7% and 63.8%. In the baseline model Medicare coverage is first applied to retiree medical expenses which lessens the cost of coverage provided by group insurers to retirees purchasing group health insurance. Under the voucher reforms group coverage is applied to the full cost of the retiree’s medical care which increases the group premium.
Table 3.2: Medicare Voucher Reforms

<table>
<thead>
<tr>
<th>Voucher Reform Economy</th>
<th>Baseline Model</th>
<th>Voucher Reform 1</th>
<th>Voucher Reform 2</th>
<th>Voucher Reform 3</th>
<th>Voucher Reform 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Premium</td>
<td>1.000</td>
<td>1.617</td>
<td>1.638</td>
<td>1.618</td>
<td>1.627</td>
</tr>
<tr>
<td>Cost Adjustment Term (c_G)</td>
<td>1.000</td>
<td>1.446</td>
<td>1.476</td>
<td>1.495</td>
<td>1.487</td>
</tr>
<tr>
<td>Aggregate Output</td>
<td>1.000</td>
<td>0.928</td>
<td>0.949</td>
<td>0.992</td>
<td>0.976</td>
</tr>
<tr>
<td>Aggregate Consumption</td>
<td>1.000</td>
<td>0.925</td>
<td>0.943</td>
<td>0.980</td>
<td>0.967</td>
</tr>
<tr>
<td>Capital Stock</td>
<td>1.000</td>
<td>0.800</td>
<td>0.857</td>
<td>0.978</td>
<td>0.931</td>
</tr>
<tr>
<td>Interest Rate</td>
<td>5.00%</td>
<td>6.75%</td>
<td>6.18%</td>
<td>5.15%</td>
<td>5.53%</td>
</tr>
<tr>
<td>Average Saving Rate</td>
<td>6.03%</td>
<td>5.04%</td>
<td>5.35%</td>
<td>6.65%</td>
<td>6.15%</td>
</tr>
</tbody>
</table>

*Health Insurance Coverage (Workers)*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Voucher Reform 1</th>
<th>Voucher Reform 2</th>
<th>Voucher Reform 3</th>
<th>Voucher Reform 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uninsured</td>
<td>29.13%</td>
<td>38.83%</td>
<td>38.65%</td>
<td>35.89%</td>
<td>36.83%</td>
</tr>
<tr>
<td>Group Insurance</td>
<td>62.32%</td>
<td>53.77%</td>
<td>53.82%</td>
<td>55.51%</td>
<td>54.81%</td>
</tr>
<tr>
<td>Nongroup Insurance</td>
<td>4.58%</td>
<td>1.88%</td>
<td>2.18%</td>
<td>4.14%</td>
<td>3.59%</td>
</tr>
<tr>
<td>Medicaid Insurance</td>
<td>3.97%</td>
<td>5.52%</td>
<td>5.35%</td>
<td>4.46%</td>
<td>4.77%</td>
</tr>
<tr>
<td>Percent Medically Needy</td>
<td>37.76%</td>
<td>42.76%</td>
<td>42.78%</td>
<td>39.19%</td>
<td>40.30%</td>
</tr>
</tbody>
</table>

*Health Insurance Coverage (Retirees)*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Voucher Reform 1</th>
<th>Voucher Reform 2</th>
<th>Voucher Reform 3</th>
<th>Voucher Reform 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uninsured</td>
<td>0.00%</td>
<td>17.54%</td>
<td>4.83%</td>
<td>2.75%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Group Insurance</td>
<td>29.57%</td>
<td>32.89%</td>
<td>34.37%</td>
<td>34.37%</td>
<td>34.37%</td>
</tr>
<tr>
<td>Traditional Medicare</td>
<td>100.00%</td>
<td>8.12%</td>
<td>10.93%</td>
<td>13.64%</td>
<td>23.50%</td>
</tr>
<tr>
<td>Nongroup (No Spend Limit)</td>
<td>0.00%</td>
<td>7.72%</td>
<td>18.16%</td>
<td>24.44%</td>
<td>18.11%</td>
</tr>
<tr>
<td>Nongroup (Spend Limit)</td>
<td>0.00%</td>
<td>13.62%</td>
<td>16.58%</td>
<td>18.05%</td>
<td>17.36%</td>
</tr>
<tr>
<td>Medicaid Insurance</td>
<td>13.37%</td>
<td>21.18%</td>
<td>18.13%</td>
<td>9.76%</td>
<td>11.06%</td>
</tr>
<tr>
<td>Percent Medically Needy</td>
<td>14.71%</td>
<td>61.23%</td>
<td>60.94%</td>
<td>30.88%</td>
<td>39.73%</td>
</tr>
</tbody>
</table>

Note: Aggregate variables are normalized by baseline model values.

Voucher Reform 1: Voucher amount applied to premiums and medical spending
Voucher Reform 2: Voucher reform 1 and voucher received only if insurance is purchased
Voucher Reform 3: Voucher reform 2 and medically needy eligibility only for insured retirees
Voucher Reform 4: Voucher reform 3 and subsidy that limits spending on traditional medicare premium to 30% of income.

Aggregate output decreases in each reform economy relative to the baseline model, which results from a decrease in the capital stock. The capital stock decreases by 20% under voucher reform 1, and 14.3% when receipt of the voucher is conditional on purchasing health insurance in voucher reform 2. The capital stock decreases by only 2.2% under Voucher reform 3 which adds insurance coverage.
among retirees as a requirement for Medicaid’s medically needy program. The capital stock decreases under voucher reform 4 by 6.9% which includes a subsidy that limits out-of-pocket spending on traditional Medicare premiums.

Implementing a voucher program impacts the health insurance purchase decisions of workers. In each reform economy the group premium increases which leads to lower group coverage among workers. Nongroup coverage decreases and Medicaid coverage increases in each of the reform economies. Changes in Medicaid coverage among workers are correlated with decreases in the capital stock which lowers the wage rate and increases the likelihood of Medicaid eligibility.

In the baseline model retirees are automatically enrolled in traditional Medicare and can obtain supplemental coverage through group insurance if it is offered or through Medicaid if eligible. When Medicare is replaced by an unconditional voucher program, as in Voucher Reform 1, 17.54% of retirees remain uninsured. The percent uninsured drops to 4.83% when the voucher receipt is conditional on purchasing insurance as in Voucher Reform 2. The presence of Medicaid’s medically needy program, which provides a form of implicit insurance against large medical expenditure shocks, reduces incentives to purchase insurance. Conditioning the voucher receipt on purchasing insurance slightly reduces Medicaid coverage among retirees and the percentage of medically needy enrollments. Requiring insurance coverage as a condition for medically needy eligibility reduces the percent of retirees uninsured from 4.83% in Voucher Reform 2 to 2.75% in Voucher Reform 3. Requiring insurance coverage for medically needy eligibility also reduces
Medicaid insurance coverage among retirees from 18.13% to 9.76%, and reduces the percent of medically needy enrollments by approximately 50%.

Conditioning the receipt of the voucher and medically needy eligibility on purchasing insurance achieves a 97.25% insurance coverage rate among retirees. As demonstrated in the Voucher Reform 4 model simulations, the remaining 2.75% of retirees forgo health insurance due to budgetary constraints. Voucher reform 4 adds a subsidy which restricts spending on traditional Medicare premiums to be no greater than 30% of income. Adding a subsidy, as in Voucher Reform 4, achieves near universal insurance coverage among retirees.

In the reform economies, traditional Medicare is community rated and therefore subject to adverse selection spirals. With the exception of voucher reform 4 which includes a subsidy, traditional Medicare remains the least chosen type of insurance among retirees. Group coverage among retirees increases in each reform economy, and to a greater extent when the receipt of the voucher is conditional.

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\(^6\)By comparison, the Patient Protection and Affordable Care Act of 2010 limits spending on premiums to be no greater than 9.5% of income for those with incomes below 400% of the Federal Poverty Level.
on purchasing insurance. With the exception of Voucher Reform 1, more retirees purchase nongroup insurance without a spending limit than purchase nongroup insurance with a spending limit. When medically needy eligibility is extended only to insured retirees, as in voucher reforms 3 and 4, Medicaid coverage among retirees is less than the baseline model.

Figures 3.10 and 3.11 display the mean and variance of out-of-pocket health spending over the retired agent’s life cycle. Health spending refers to medical expenditures and premiums net of the voucher amount. Each voucher reform profile is normalized by the baseline model profile. Values less than one indicate a decrease relative to the baseline model. In each reform economy, retirees younger than 75 experience a decrease in average out-of-pocket health spending as compared to the baseline model. Average health spending in voucher reforms 1 and 2 is below that of the baseline model over the retired agent’s life cycle. This may be attributed to the increase in Medicaid coverage in these two reform economies and the generous coverage provided by Medicaid.

In voucher reforms 3 and 4, average health spending increases linearly relative to the baseline model. Retirees older than 75 spend on average more on health than retirees in the baseline model. Average out-of-pocket spending by the oldest retirees is nearly twice as high in voucher reform 4 than in the baseline model. Figure 3.11 plots the variance of health spending, relative to the baseline profile, over the retirees life span. The large increase in the variance of out-of-pocket health spending observed in voucher reform 3 results from the addition of insurance cov-
Table 3.3: Government Social Insurance Expenditures

<table>
<thead>
<tr>
<th>Voucher Reform Economy</th>
<th>Baseline Model</th>
<th>Voucher Reform 1</th>
<th>Voucher Reform 2</th>
<th>Voucher Reform 3</th>
<th>Voucher Reform 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transfer Cost</td>
<td>1.000</td>
<td>1.341</td>
<td>0.914</td>
<td>40.728</td>
<td>0.579</td>
</tr>
<tr>
<td>Medicaid Cost</td>
<td>1.000</td>
<td>3.219</td>
<td>2.765</td>
<td>1.471</td>
<td>1.593</td>
</tr>
<tr>
<td>Retiree Insurance Cost</td>
<td>1.000</td>
<td>0.513</td>
<td>0.535</td>
<td>0.639</td>
<td>0.696</td>
</tr>
</tbody>
</table>

Social Insurance Spending as a Percent of Government Spending

|                      | 27.30% | 26.76% | 25.56% | 23.43% | 24.16% |

Note: Aggregate variables are normalized by baseline model values. Government spending is defined as the cost of social insurance programs plus the mandatory spending $G$.

verage as an eligibility requirement for Medicaid’s medically needy program. The increase in the variance of health spending is comparable between voucher reforms 1, 2 and 4. For all retired agents, health spending is more dispersed under the voucher reforms as compared to the baseline model.

Table 3.3 compares social insurance expenditures in the baseline model and the four voucher reform economies. Overall, social insurance expenditures relative to Government spending, decrease in each reform economy as compared to the baseline model. Relative to the baseline model, transfer costs increase under voucher reforms 1 and 3 and decrease under voucher reforms 2 and 4. Under voucher reform 3, the uninsured lack access to Medicaid’s medically needy program. Transfers are made net of out-of-pocket medical expenditures, which accounts for the large increase observed under voucher reform 3.

Medicaid costs increase dramatically under each reform economy. In the baseline model Medicaid coverage applies to out-of-pocket spending following Medicare whereas Medicaid applies to the full cost of retirees medical spending under
the voucher reforms. The increase in Medicaid spending is correlated with the increase in medically needy enrollments among retirees, as shown in table 3.2. Government spending on retiree insurance is the cost of operating Medicare in the baseline model, or the cost associated with voucher transfers in the reform economies. Retiree insurance costs decrease between 30.4% and 48.7% relative to the baseline model. The voucher amount equals the average subsidy received through the Medicare payroll tax in the baseline model. Retirees with medical spending exceeding the voucher amount are responsible for the difference.

Welfare Comparisons

Welfare changes are calculated in terms of consumption equivalent variation (C.E.V.) which measures the percentage change in consumption required in the baseline model to equate expected utilities with an agent born into the reform economy.\(^7\) Negative values correspond to welfare losses. Welfare implications from the voucher reforms are presented in table 3.4.

Replacing Medicare with any of the voucher reforms considered results in a welfare loss for newly born agents. Welfare losses for newly born agents are correlated with changes in the capital stock as shown in table 3.2. An unconditional voucher program results in the largest welfare loss. The welfare loss decreases when receipt of the voucher is conditional on purchasing insurance and when medically needy eligibility is extended only to insured retirees. Adding a subsidy which

\(^7\)Let \(EV^B\) denote expected utility of an agent born into the baseline economy and \(EV^R\) denote expected utility of an agent born into the reform economy. CEV is defined as \(CEV = (EV^B/EV^R)^{1/(1-\sigma)} - 1\)
limits out-of-pocket spending for traditional medicare premiums, as in voucher reform 4, increases the welfare loss as compared to voucher reform 3.

The last three rows of table 3.4 presents expected welfare changes for agents entering retirement. Retirees experience an expected welfare gain in each of the four voucher reform economies relative to retirees in the baseline model. The magnitude of the welfare gain is largest when the voucher subsidy is transferred unconditionally. Conditioning the voucher receipt on purchasing insurance (voucher reform 2) reduces the expected welfare gain experienced by retirees compared to the unconditional voucher reform 1. Prohibiting uninsured retirees from receiving medically needy benefits (voucher reform 3) increases the expected welfare gain, and including a subsidy (voucher reform 4) further increases the expected welfare gain.

Agents entering retirement with an offer to purchase group insurance from their former employer experience a welfare gain in each reform economy. For retirees, group insurance is subsidized both by their former employer and by workers purchasing community rated group insurance. The group premium is the lowest
among available plans for retirees so that retirees who purchase group insurance are able to apply the voucher subsidy to the cost of purchasing group insurance and also towards offsetting out-of-pocket medical expenses. Retirees who do not receive an offer to purchase group insurance experience an expected welfare gain when the voucher is unconditionally transferred (voucher reform 1), but they experience an expected welfare loss under the remaining reforms.

Figure 3.12 presents welfare changes by age in each voucher reform relative to the baseline model. The age profile for welfare changes is increasing in voucher reforms 1 and 2. Workers under each of the voucher reforms experience expected welfare losses whereas retirees experience expected welfare gains under voucher reforms 1 and 2. Expected welfare gains are experienced by retirees younger than 75 in voucher reform 3, and retirees younger than 95 in voucher reform 4. Expected welfare losses decrease sharply as retirees age under voucher reform 3.

Figure 3.13 presents welfare changes for retirees by Medicaid eligibility, which includes both categorical and medically needy participants. In all cases, Medicaid
eligible retirees experience greater welfare gains compared to retirees not eligible for Medicaid coverage. Retirees in the voucher reform 1 economy experience an expected welfare gain independent of Medicaid eligibility and retirees in voucher reform 2, with the exception of Medicaid ineligible retirees younger than 75, experience an expected welfare gain. Medicaid ineligible retirees in voucher reforms 3 and 4, which includes the uninsured who are ineligible for medically needy coverage, experience an expected welfare loss. Medicaid eligible retirees experience an expected welfare gain under voucher reforms 3 and 4 and the expected welfare gain is decreasing over age.

**Figure 3.13:** C.E.V. for Retirees by Medicaid Eligibility
Table 3.5: Comparing Retirees by Insurance Status

<table>
<thead>
<tr>
<th></th>
<th>Voucher Reform 1</th>
<th>Voucher Reform 2</th>
<th>Voucher Reform 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent Uninsured</td>
<td>17.54%</td>
<td>4.83%</td>
<td>2.75%</td>
</tr>
<tr>
<td>Age (in years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uninsured</td>
<td>76.5</td>
<td>80.6</td>
<td>83.1</td>
</tr>
<tr>
<td>Insured</td>
<td>75.1</td>
<td>75.0</td>
<td>75.1</td>
</tr>
<tr>
<td>Savings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uninsured</td>
<td>$58,840</td>
<td>$2,607</td>
<td>$1,504</td>
</tr>
<tr>
<td>Insured</td>
<td>$125,614</td>
<td>$133,540</td>
<td>$155,391</td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uninsured</td>
<td>$14,769</td>
<td>$10,290</td>
<td>$8,414</td>
</tr>
<tr>
<td>Insured</td>
<td>$20,369</td>
<td>$20,187</td>
<td>$20,293</td>
</tr>
<tr>
<td>Health Status&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uninsured</td>
<td>1.577</td>
<td>1.152</td>
<td>1.009</td>
</tr>
<tr>
<td>Insured</td>
<td>1.730</td>
<td>1.731</td>
<td>1.725</td>
</tr>
<tr>
<td>Group Insurance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eligible</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uninsured</td>
<td>0.250%</td>
<td>0.000%</td>
<td>0.000%</td>
</tr>
<tr>
<td>Insured</td>
<td>39.995%</td>
<td>36.116%</td>
<td>35.341%</td>
</tr>
<tr>
<td>Net Cost of Insurance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relative to Income&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uninsured</td>
<td>0.139</td>
<td>0.369</td>
<td>0.598</td>
</tr>
<tr>
<td>Insured</td>
<td>0.066</td>
<td>0.143</td>
<td>0.132</td>
</tr>
</tbody>
</table>

<sup>a</sup> Health status is ranked on a scale from 1 to 4 where 1 is poor health and 4 is excellent health.

<sup>b</sup> Net cost of insurance is the cost of health insurance that exceeds the voucher amount. Premiums for the uninsured refer to the lowest cost health insurance plan.

Comparing Retirees by Insurance Status and Health Spending

The analysis of the previous sections found that replacing Medicare with a voucher program resulted in a portion of the retired population remaining uninsured which varied from a high of 17.54% under voucher reform 1 to a low of 2.75% under voucher reform 3. This section examines the differences between retirees by insurance status. The baseline model is excluded since all retirees are enrolled in traditional Medicare, and voucher reform 4 is excluded since near universal coverage among retirees was attained.

Table 3.5 presents a comparison of insured and uninsured retirees under voucher
reforms 1-3. In each reform economy the uninsured are older on average than those with health insurance. The uninsured tend to have significantly lower savings and income than retirees with health insurance. Savings among the uninsured ranges from $1,504 under voucher reform 3 to $58,840 under voucher reform 1. By contrast, insured retirees have on average greater than $125,000 in savings. Average income among the uninsured, which includes Social Security benefits and capital income, varies between $8,414 and $14,769. This compares to the average income of over $20,00 among insured retirees.

The uninsured tend to be in poorer health compared to insured retirees. Retirees in worse health face higher premiums in the nongroup market and are more likely to have insurance premiums which exceed the voucher amount. Virtually none of the uninsured have received an offer from their former employer to purchase group insurance in retirement. This compares with over 35% of the insured in each voucher reform.

The final two rows of table 3.5 compare the net cost of insurance, relative to income by insurance status. For the uninsured, the net cost of insurance is the lowest cost policy net of the Medicare voucher. The net cost of insurance relative to income for the insured excludes those covered by Medicaid. The cost of purchasing insurance varies between 13.9% to 59.8% of income for the uninsured. The insured spent on average between 6.6% and 14.3% of their income on health insurance premiums, suggesting that budgetary constraints may contribute to the decision to forgo insurance for some retirees.
3.7.3 Removing Retiree Group Insurance Offer

In the baseline model retiree medical expenses are partially insured through Medicare. Retirees who purchase group insurance through their former employer as a supplement to Medicare receive further coverage applied to out-of-pocket expenses following Medicare. When Medicare is replaced by a voucher system, group health insurance coverage is applied to the full cost of the retiree’s medical care. If firms do not change their offer rates to retirees then the result, as show in the previous section, is a large increase in the group insurance premium. The increased group premium translates to an increased cost adjustment term which lowers the labor earnings of agents matched with firms offering group health insurance.

Firms may respond to the increased cost of retiree insurance benefits by reducing or eliminating insurance offers to retirees. In this section, the voucher reforms are simulated under the assumption that firms offering group health insurance respond by eliminating insurance offers to retirees. This assumption contrasts with the previous section which assumes that firms do not change their insurance offer probability to retirees following the reforms.

Table 3.6 presents the results from model simulations assuming retirees are not offered insurance through their former employer so that $\pi = 0$. The group insurance premium increases between 5.4% and 6.2% under the voucher reforms. This compares with an increase in the group premium between 61.7% and 63.8% when retirees receive group insurance offers from their former employer.

The capital stock decreases to a lesser extent under voucher reforms 1 and 2.
Table 3.6: Medicare Voucher Reforms (No Retiree Insurance Offers)

<table>
<thead>
<tr>
<th></th>
<th>Baseline Model</th>
<th>Voucher Reform 1</th>
<th>Voucher Reform 2</th>
<th>Voucher Reform 3</th>
<th>Voucher Reform 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Premium</td>
<td>1.000</td>
<td>1.062</td>
<td>1.057</td>
<td>1.054</td>
<td>1.056</td>
</tr>
<tr>
<td>Cost Adjustment Term</td>
<td>1.000</td>
<td>0.909</td>
<td>0.910</td>
<td>0.933</td>
<td>0.921</td>
</tr>
<tr>
<td>Aggregate Output</td>
<td>1.000</td>
<td>0.938</td>
<td>0.970</td>
<td>1.038</td>
<td>1.006</td>
</tr>
<tr>
<td>Aggregate Consumption</td>
<td>1.000</td>
<td>0.940</td>
<td>0.965</td>
<td>1.017</td>
<td>0.997</td>
</tr>
<tr>
<td>Capital Stock</td>
<td>1.000</td>
<td>0.826</td>
<td>0.913</td>
<td>1.120</td>
<td>1.020</td>
</tr>
<tr>
<td>Interest Rate</td>
<td>5.00%</td>
<td>6.49%</td>
<td>5.68%</td>
<td>4.20%</td>
<td>4.85%</td>
</tr>
</tbody>
</table>

*Health Insurance Coverage (Workers)*

<table>
<thead>
<tr>
<th></th>
<th>Uninsured</th>
<th>Group Insurance</th>
<th>Nongroup Insurance</th>
<th>Medicaid Insurance</th>
<th>Medically Needy Enrollments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voucher Reform 1</td>
<td>29.13%</td>
<td>62.32%</td>
<td>4.58%</td>
<td>3.97%</td>
<td>37.76%</td>
</tr>
<tr>
<td>Voucher Reform 2</td>
<td>32.44%</td>
<td>60.54%</td>
<td>5.05%</td>
<td>5.05%</td>
<td>40.67%</td>
</tr>
<tr>
<td>Voucher Reform 3</td>
<td>31.89%</td>
<td>60.93%</td>
<td>4.79%</td>
<td>4.79%</td>
<td>40.77%</td>
</tr>
<tr>
<td>Voucher Reform 4</td>
<td>27.80%</td>
<td>62.74%</td>
<td>3.47%</td>
<td>3.47%</td>
<td>38.51%</td>
</tr>
</tbody>
</table>

*Health Insurance Coverage (Retirees)*

<table>
<thead>
<tr>
<th></th>
<th>Uninsured</th>
<th>Group Insurance</th>
<th>Traditional Medicare</th>
<th>Nongroup (No Spending Limit)</th>
<th>Nongroup (Spending Limit)</th>
<th>Medicaid Insurance</th>
<th>Medically Needy Enrollments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voucher Reform 1</td>
<td>0.00%</td>
<td>29.57%</td>
<td>100.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>13.37%</td>
<td>14.71%</td>
</tr>
<tr>
<td>Voucher Reform 2</td>
<td>26.48%</td>
<td>12.06%</td>
<td>12.86%</td>
<td>12.41%</td>
<td>21.41%</td>
<td>27.56%</td>
<td>63.45%</td>
</tr>
<tr>
<td>Voucher Reform 3</td>
<td>7.17%</td>
<td>18.13%</td>
<td>28.01%</td>
<td>25.91%</td>
<td>25.91%</td>
<td>23.17%</td>
<td>60.15%</td>
</tr>
<tr>
<td>Voucher Reform 4</td>
<td>6.76%</td>
<td>23.09%</td>
<td>38.13%</td>
<td>29.29%</td>
<td>29.29%</td>
<td>5.01%</td>
<td>45.63%</td>
</tr>
</tbody>
</table>

Note: Aggregate variables are normalized by baseline model values.

Voucher Reform 1: Voucher amount applied to premiums and medical spending
Voucher Reform 2: Voucher reform 1 and voucher received only if insurance is purchased
Voucher Reform 3: Voucher reform 2 and medically needy eligibility only for insured retirees
Voucher Reform 4: Voucher reform 3 and subsidy that limits spending on traditional medicare premium to 30% of income.

when retirees do not receive group insurance offered compared to the model that includes retiree group insurance offers. The capital stock increases 12% under voucher reform 3 and 2% under voucher reform 4, both of which include insurance coverage as a requirement for Medicaid’s medically needy eligibility. The fraction of retirees who are uninsured is higher under voucher reforms 1-3 when retirees do not receive group insurance offers.
Table 3.7: Government Social Insurance Expenditures, Welfare

<table>
<thead>
<tr>
<th></th>
<th>Baseline Model</th>
<th>Voucher Reform 1</th>
<th>Voucher Reform 2</th>
<th>Voucher Reform 3</th>
<th>Voucher Reform 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transfer Cost</td>
<td>1.000</td>
<td>1.243</td>
<td>0.683</td>
<td>100.829</td>
<td>0.313</td>
</tr>
<tr>
<td>Medicaid Cost</td>
<td>1.000</td>
<td>3.950</td>
<td>3.337</td>
<td>0.935</td>
<td>1.658</td>
</tr>
<tr>
<td>Retiree Insurance Cost</td>
<td>1.000</td>
<td>0.631</td>
<td>0.676</td>
<td>0.863</td>
<td>0.910</td>
</tr>
</tbody>
</table>

Social Insurance Spending as a Percent of Government Spending

<table>
<thead>
<tr>
<th></th>
<th>Baseline Model</th>
<th>Voucher Reform 1</th>
<th>Voucher Reform 2</th>
<th>Voucher Reform 3</th>
<th>Voucher Reform 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.E.V. (Newborns)</td>
<td>–</td>
<td>-5.57%</td>
<td>-1.80%</td>
<td>3.03%</td>
<td>2.33%</td>
</tr>
<tr>
<td>C.E.V. (Retirees)</td>
<td>–</td>
<td>2.03%</td>
<td>-0.26%</td>
<td>-4.35%</td>
<td>2.10%</td>
</tr>
</tbody>
</table>

Note: Aggregate variables are normalized by baseline model values. Government spending is defined as the cost of social insurance programs plus the mandatory spending G.

Near universal coverage is achieved in voucher reform 4 independent of whether retirees receive group insurance offers. Changes in insurance coverage rates among workers is much less pronounced when retirees do not receive offers to purchase group insurance. Insurance coverage among workers decreases under voucher reforms 1 and 2, and insurance coverage rates under voucher reforms 3 and 4 are similar to the baseline model. With the exception of voucher reform 3, Medicaid coverage among retirees is higher when retirees do not receive group insurance offers and medically needy enrollments represent a much larger share of retiree Medicaid enrollments in the reform economies as compared to the baseline model. Private insurance coverage is similar between the case where retirees receive group insurance offers and the case when they do not.

Table 3.7 presents social insurance expenditures in the baseline and reform economies as well as welfare calculations for newborns and agents entering retire-
Social insurance expenditures as a percentage of total government spending increase in each voucher reform economy with the exception of voucher reform 3, which prohibits the uninsured from receiving Medicaid's medically needy coverage. Transfer costs to achieve the minimum consumption floor increase under voucher reforms 1 and 3 and decrease under voucher reforms 2 and 4. The cost of providing Medicaid coverage increases in each voucher reform with the exception of voucher reform 3. Under each voucher reform the costs attributed to retiree health insurance decrease relative to the cost of operating the Medicare health insurance program in the baseline model.

Agents entering voucher reform economies 1 and 2 experience an expected welfare loss relative to the baseline model and agents entering voucher reform economies 3 and 4 experience an expected welfare gain relative to the baseline model. An expected welfare gain is experienced for agents entering retirement under voucher reforms 1 and 4 whereas an expected welfare loss is experienced by agents entering voucher reform economies 2 and 3.

3.8 Conclusion

To study the effects of Medicare voucher reforms, a general equilibrium life cycle model is developed which includes stochastic medical expenditure shocks and endogenous health insurance purchase decisions. Workers, who are heterogeneous in their productivity, can partially insure against uncertain medical expenditure
shocks by purchasing nongroup insurance, employer subsidized and tax preferred group insurance if it is offered through the workplace or obtain coverage through Medicaid which is means tested. Retirees in the baseline model are enrolled in Medicare and can obtain supplemental coverage in the group market if insurance is offered through their former employer or through Medicaid if they qualify. The model is calibrated to match key moments of the U.S. economy and life cycle profiles observed in the Medical Expenditure and Panel Survey (MEPS) data set.

Under the reform, retirees receive transfer from the Government which may be applied towards the cost of medical care and purchasing health insurance. Variants of the Medicare voucher program are considered which include conditioning the voucher receipt on the purchase of health insurance and reforms to Medicaid’s medically needy program for retirees. Welfare gains can be achieved if Medicaid’s medically needy benefits and the voucher are available only to insured retirees and if the reform includes a subsidy which limits spending on traditional Medicare premiums to no more than 30% of income.

Retiree health insurance coverage rates depend crucially on how the Voucher reform is structured. Transferring the voucher unconditionally results in 17.5% of retirees remaining uninsured. The percent uninsured is reduced to 4.8% when receipt of the voucher is conditional on purchasing insurance. The presence of Medicaid’s medically needy program provides a form of implicit insurance against large medical expense shocks and reduces insurance purchase and savings motives among retirees. Requiring insurance coverage as a condition for medically needy
eligibility among retirees results in 2.75% of retirees remaining uninsured. Those remaining uninsured may choose to forgo insurance due to budgetary constraints. Adding a subsidy to the voucher reform which restricts spending on traditional Medicare premiums to 30% of income achieves near universal coverage among retirees.

The cost to firms who offer retirees insurance is partially subsidized by Medicare under the current system since group coverage applies to out-of-pocket expenses following Medicare. If Medicare is replaced by a voucher system, group coverage applies to the full cost of retirees medical expenses. This raises the cost to firms that contribute towards retiree insurance and increases the group premium, which adversely impacts working agents. If firms respond to the reforms by eliminating retiree insurance offers then social insurance spending by the government, relative to total government spending, increases under the voucher reform that achieves the highest rate of insurance coverage among retirees.
Bibliography


American Journal of Respiratory and Critical Care Medicine, 152(5), 1435-1442.


Table 3.8: MEPS Panel Sample Size

<table>
<thead>
<tr>
<th>Panel</th>
<th>Sample</th>
<th>age &lt; 65</th>
<th>age ≥ 65</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000 - 2001</td>
<td>1,863</td>
<td>1,487</td>
<td>376</td>
</tr>
<tr>
<td>2001 - 2002</td>
<td>4,210</td>
<td>3,423</td>
<td>787</td>
</tr>
<tr>
<td>2002 - 2003</td>
<td>6,146</td>
<td>4,974</td>
<td>1,172</td>
</tr>
<tr>
<td>2003 - 2004</td>
<td>6,223</td>
<td>4,947</td>
<td>1,276</td>
</tr>
<tr>
<td>2004 - 2005</td>
<td>5,940</td>
<td>4,823</td>
<td>1,117</td>
</tr>
<tr>
<td>2005 - 2006</td>
<td>6,036</td>
<td>4,805</td>
<td>1,231</td>
</tr>
<tr>
<td>2006 - 2007</td>
<td>6,514</td>
<td>5,188</td>
<td>1,326</td>
</tr>
<tr>
<td>2007 - 2008</td>
<td>4,966</td>
<td>4,009</td>
<td>957</td>
</tr>
<tr>
<td>2008 - 2009</td>
<td>5,105</td>
<td>4,294</td>
<td>811</td>
</tr>
<tr>
<td>2009 - 2010</td>
<td>3,128</td>
<td>2,567</td>
<td>561</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>50,131</strong></td>
<td><strong>40,517</strong></td>
<td><strong>9,614</strong></td>
</tr>
</tbody>
</table>

3.A Data Appendix

3.A.1 Sample Selection

Individuals surveyed for the MEPS are grouped according to Health Insurance Eligibility Units (HIEUs) which are defined as sub-family relationships comprised of adults plus any insurance eligible family members. The MEPS does not explicitly define the head of each HIEU so instead, following Jeske and Kitao(2009), the head of each HIEU is defined as the person with the highest labor income (using variable wagepY1x and wagepY2x, where Y1 and Y2 denotes the panel year). Individuals younger than 25 in the first panel year are dropped from the sample as are those older than 65 who report not being covered by Medicare. The resulting sample consists of 10 two-year panels from 2000/2001 until 2009/2010. Sample sizes are reported in table 3.8. All calculations utilize the longitudinal sample weights provided in the MEPS data.
3.A.2 Medical Expenditure Shocks

Medical expenditure shocks are estimated from the MEPS panel data using data on total medical expenditures (variables totexpY1 and totexpY2 for panel years 1 and 2) normalized by the sample average income of $33,024. Individuals are sorted into 5 bins depending on where they fall within their age specific spending distribution corresponding to the 50th, 70th, 90th and 99th percentiles. Medical expenditure shocks are calculated as the average medical expenditure within each bin and for each age group.

To calculate medical expenditure shocks for ages not observed in the sample, and to smooth the medical expenditure shock values over age, a cubic polynomial was fit to each data profile. The fitted polynomial was extended beyond the maximum age observed in the MEPS sample of 85 to estimate shock values. The medical expenditure shock profiles observed in the data and the fitted polynomials are displayed in figure 3.14.
Table 3.9: Age Component Estimation Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.32879</td>
<td>(0.16427)**</td>
</tr>
<tr>
<td>Age</td>
<td>0.04841</td>
<td>(0.00733)***</td>
</tr>
<tr>
<td>Age Squared</td>
<td>-0.00054</td>
<td>(0.00008)***</td>
</tr>
<tr>
<td>Fair Health</td>
<td>-1.11209</td>
<td>(0.20694)***</td>
</tr>
<tr>
<td>Good Health</td>
<td>-1.19515</td>
<td>(0.20070)***</td>
</tr>
<tr>
<td>Excellent Health</td>
<td>-1.37217</td>
<td>(0.19818)***</td>
</tr>
<tr>
<td>Age×Fair Health</td>
<td>0.06527</td>
<td>(0.00940)***</td>
</tr>
<tr>
<td>Age×Good Health</td>
<td>0.07995</td>
<td>(0.00920)***</td>
</tr>
<tr>
<td>Age×Excellent Health</td>
<td>0.09230</td>
<td>(0.00914)***</td>
</tr>
<tr>
<td>Age Squared×Fair Health</td>
<td>-0.00065</td>
<td>(0.00010)***</td>
</tr>
<tr>
<td>Age Squared×Good Health</td>
<td>-0.00082</td>
<td>(0.00010)***</td>
</tr>
<tr>
<td>Age Squared×Excellent Health</td>
<td>-0.00094</td>
<td>(0.00010)***</td>
</tr>
</tbody>
</table>

Significance at the 1% and 5% levels is denoted ** and *, respectively.

The distribution of medical expenditure shocks is estimated as the fraction of individuals observed in each medical expenditure shock bin conditional on health status. The distribution of medical expenditure shocks by health status is,

\[
f_m(m_j | H_j) = \begin{pmatrix}
0.327 & 0.190 & 0.274 & 0.181 & 0.029 \\
0.507 & 0.206 & 0.200 & 0.080 & 0.007 \\
0.588 & 0.195 & 0.161 & 0.053 & 0.004 \\
0.577 & 0.209 & 0.166 & 0.046 & 0.002
\end{pmatrix}
\]
3.A.3 Productivity Shocks and Group Health Insurance Offer

The productivity process is characterized by a persistent component and an age varying deterministic component that depends on health status. Using labor income (variables wagepY1x and wagepY2x) from the MEPS sample, the deterministic component is estimated from the regression,

\[ \text{inc} = \beta_0 + \beta_1 \text{age} + \beta_2 \text{age}^2 + \beta_3 H + \beta_4 H \times \text{age} + \beta_5 H \times \text{age}^2 + \epsilon \]

where \( \text{inc} \) denotes income normalized by the sample average income and \( H \) denotes health status. OLS estimates are presented in table 3.9. The age profiles conditional on health status, which are displayed in figure 3.5, are calculated using the estimates from table 3.9.

MEPS participants were asked on three separate occasions whether they received an offer to purchase group insurance through the workplace (variables offer31x, offer42x, offer53x). Survey participants are assumed to receive an offer to purchase group health insurance if they answered affirmatively to any of these three questions. Group insurance offer probabilities, \( f_G(z, j) \), are estimated from the MEPS data with a logistic regression,

\[ Pr(i_G = 1|z, j) = \frac{\exp(\beta_0 + \beta_1 j + \beta_2 j^2 + \beta_3 z + \beta_4 z \times j)}{1 + \exp(\beta_0 + \beta_1 j + \beta_2 j^2 + \beta_3 z + \beta_4 z \times j)} \]
where \( j \) denotes age and \( z \) is the persistent component of labor income, calculated as labor income divided by the health status contingent age component and normalized by a constant so that the average persistent component in the data equals that of the model. The estimated coefficients along with age and the values of the persistent component are used to calculate offer probabilities. The offer probabilities, conditional on age and productivity are displayed in figure 3.15.

### 3.A.4 Health Insurance

Health insurance coverage is determined using responses to monthly questions for group coverage (\( \text{pegjaY1-pegdeY1} \) and \( \text{pegjaY2-pegdeY2} \)), nongroup coverage (\( \text{prijaY1-prideY1} \) and \( \text{prijaY2-prideY2} \)) and Medicaid coverage (\( \text{mcdjaY1-mcddeY1} \) and \( \text{mcdjaY2-mcddeY2} \)). An individual is assumed to be covered by group, nongroup or Medicaid if they were covered under either category for at least 7 months of the year. Medicare coverage is determined using the variables
Table 3.10: Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Working Population</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Full Sample</td>
</tr>
<tr>
<td>Sample Size</td>
<td>89,901</td>
</tr>
<tr>
<td><strong>Demographic Variables</strong></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>49.581</td>
</tr>
<tr>
<td>No High School Degree</td>
<td>0.195</td>
</tr>
<tr>
<td></td>
<td>(0.396)</td>
</tr>
<tr>
<td>High School Degree</td>
<td>0.446</td>
</tr>
<tr>
<td></td>
<td>(0.497)</td>
</tr>
<tr>
<td>College Degree</td>
<td>0.360</td>
</tr>
<tr>
<td></td>
<td>(0.480)</td>
</tr>
<tr>
<td>Married</td>
<td>0.435</td>
</tr>
<tr>
<td></td>
<td>(0.496)</td>
</tr>
<tr>
<td>Male</td>
<td>0.498</td>
</tr>
<tr>
<td></td>
<td>(0.500)</td>
</tr>
<tr>
<td><strong>Health Related Variables</strong></td>
<td></td>
</tr>
<tr>
<td>PCS Score</td>
<td>49.140</td>
</tr>
<tr>
<td></td>
<td>(10.664)</td>
</tr>
<tr>
<td>Smoker</td>
<td>0.218</td>
</tr>
<tr>
<td></td>
<td>(0.413)</td>
</tr>
<tr>
<td>Emergency Room Visits</td>
<td>0.190</td>
</tr>
<tr>
<td></td>
<td>(0.584)</td>
</tr>
<tr>
<td>Total Medical Spending</td>
<td>$4,346</td>
</tr>
<tr>
<td></td>
<td>($12,045)</td>
</tr>
<tr>
<td>Income</td>
<td>$33,600</td>
</tr>
<tr>
<td></td>
<td>($35,179)</td>
</tr>
</tbody>
</table>

Note: Standard deviations are reported in parentheses. Insured includes those covered by private insurance or Medicare for retirees.

* The Physical Component Summary (PCS) Score is a continuous variable ranging from 0-100 with higher values corresponding to better health

mcrevY1 for panel year 1 and mcrevY2 for panel year 2 which asks whether an individual was ever covered by public insurance during each panel year.
3.A.5 Health Status Transition Probabilities

Health status transition probabilities are estimated from the 2-year MEPS sample. Health status, which assumes four discrete states, is calculated from the physical component summary score contained in the MEPS. Survey respondents are sorted into four equally sized bins which are labeled poor health, fair health, good health and excellent health. Disabled individuals, identified as those receiving supplemental security income, are excluded from the estimation.

Transition probabilities, which are dependent on current health status, age and insurance coverage, are estimated from the 2-year MEPS panel using a multinomial logit model,

$$Pr(H_2 = H_j) = \frac{\exp(\beta'_{1j} H_1 + \beta_{2j} ins_1 + \beta_{3j} ins_1 \times H_1 + \beta_{4j} ins_1 \times age_1 + \beta_{5j} X_1)}{1 + \sum_{k=1}^{3} \exp(\beta'_{1k} H_1 + \beta_{2k} ins_1 + \beta_{3k} ins_1 \times H_1 + \beta_{4k} ins_1 \times age_1 + \beta_{5k} X_1)}$$

where $H_2$ denotes health status in panel year 2, $H_1$ is a vector of dummy variables indicating health status in panel year 1, $ins_1$ indicates private insurance coverage among those younger than 65 in panel year 1 and $age_1$ denotes age in panel year 1. The vector $X_1$ contains demographic variables which includes age, age squared, a dummy variable indicating age greater than 65, education, marital status, total medical spending, income, gender, smoking status and the number of emergency room visits.

Excluding demographic measures from the model might bias the estimated ef-
fect of insurance coverage if differences in demographics between the insured and uninsured also influence health outcomes. Table 3.10 presents descriptive statistics for the full sample, uninsured and privately insured workers (age < 65), and retirees. Among the working population, the uninsured tend to be younger, less educated, in worse health, more likely to smoke, have lower incomes and spend less on medical care. On average, the uninsured visit the emergency room more frequently as compared to the privately insured. Emergency care represents one of the primary sources of health care for the uninsured (Pitts et al., 2010), and failure to control for this source of care could bias the estimated effect from private insurance on health status.

Table 3.11 presents the estimated coefficients and standard errors from the multinomial logit estimation along with results from likelihood ratio tests which tested the joint significance of the insurance variables. Restricted models exclude all insurance variables, and only insurance interaction terms. All insurance variables, and the interaction terms are found to be jointly significant.

Annual transition probabilities, conditional on age health status and insurance coverage, are calculated using the estimates from table 3.11. For retirees, those older than 65, the insurance coverage variables are set to zero and the dummy variable for retirement is set equal to one. Individuals in the sample who are older than 65 and did not report Medicare coverage were dropped from the sample. The retirement dummy variable accounts for any variation in health outcomes among retirees that can be attributed to Medicare insurance coverage. Demographic vari-
Table 3.11: Health Transition Estimation Results

<table>
<thead>
<tr>
<th>Health Variables</th>
<th>Fair Health</th>
<th>Good Health</th>
<th>Excellent Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.210 (0.196)</td>
<td>-0.421 (0.228)*</td>
<td>-0.352 (0.250)</td>
</tr>
<tr>
<td><em>Health Variables</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fair Health</td>
<td>1.708 (0.052)***</td>
<td>2.431 (0.077)***</td>
<td>2.384 (0.097)***</td>
</tr>
<tr>
<td>Good Health</td>
<td>2.303 (0.076)***</td>
<td>3.879 (0.093)***</td>
<td>3.940 (0.107)***</td>
</tr>
<tr>
<td>Excellent Health</td>
<td>2.372 (0.096)***</td>
<td>3.947 (0.109)***</td>
<td>4.818 (0.118)***</td>
</tr>
<tr>
<td>E.R. Visits a</td>
<td>-0.141 (0.025)***</td>
<td>-0.213 (0.032)***</td>
<td>-0.318 (0.037)***</td>
</tr>
<tr>
<td>Medical Spending</td>
<td>-0.413 (0.057)***</td>
<td>-0.781 (0.088)***</td>
<td>-0.789 (0.100)***</td>
</tr>
</tbody>
</table>

| Demographic Variables |            |             |                  |
| Retired              | 0.219 (0.074)*** | 0.215 (0.093)** | 0.276 (0.108)** |
| Less Than H.S.       | -0.081 (0.038)** | -0.207 (0.043)*** | -0.224 (0.047)*** |
| College Degree       | 0.066 (0.042)   | 0.127 (0.046)*** | 0.419 (0.047)*** |
| Married              | 0.101 (0.034)*** | 0.080 (0.038)** | 0.010 (0.040)   |
| Income               | 0.156 (0.025)*** | 0.245 (0.026)*** | 0.270 (0.027)*** |
| Male                 | 0.113 (0.033)*** | 0.207 (0.037)*** | 0.124 (0.039)*** |
| Smoker               | -0.162 (0.039)*** | -0.226 (0.043)*** | -0.416 (0.046)*** |
| Age                  | -0.013 (0.008)* | -0.043 (0.009)*** | -0.046 (0.010)*** |
| Age Squared          | -1.2e^-4 (7.62e^-5) | 2.79e^-5 (9.48e^-5) | -8.86e^-5 (1.1e^-4) |

| Insurance Variables (Ins.) |            |             |                  |
| Insurance Coverage       | 0.275 (0.129)** | 0.677 (0.154)*** | 0.537 (0.171)*** |
| Age×Ins.                | -0.000 (0.002)* | -0.004 (0.002)*** | -0.002 (0.003)   |
| Fair Health×Ins.        | -0.069 (0.073) | -0.241 (0.105)** | -0.414 (0.128)*** |
| Good Health×Ins.        | -0.143 (0.103) | -0.252 (0.123)** | -0.359 (0.140)** |
| Excellent Health×Ins.   | -0.186 (0.130) | -0.279 (0.144)* | -0.250 (0.156)   |

Likelihood Ratio Tests

<table>
<thead>
<tr>
<th>D.F.</th>
<th>χ²</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>86.21***</td>
</tr>
<tr>
<td>12</td>
<td>26.68***</td>
</tr>
</tbody>
</table>

Poor health is the base case. Standard errors are reported in parenthesis. Significance at the 1%, 5% and 10% levels is denoted "***", "**" and ", respectively.

Figure 3.16 plots the ratio of conditional transition probabilities over age for the uninsured relative to the privately insured. Values greater than one indicate a higher probability of transitioning to a certain health state for the uninsured compared to the privately insured. As shown in the upper left plot, the uninsured have a higher probability of transitioning to poor health. With the exception of...
Figure 3.16: Transition Probabilities for the Uninsured Relative to the Insured

Poor health, the uninsured have a higher probability of transitioning to fair health as shown in the upper right plot. The lower two plots indicate that the uninsured have a lower probability of transitioning to good and excellent health as compared to the privately insured.
3.B Computational Appendix

The algorithm used to compute the stationary equilibrium is as follows,

1. Discretize the state space for capital into $N_K = 700$ unevenly spaced points $k \in \{k_1, k_2, \ldots, k_{N_K}\}$ where the upper bound on the grid is chosen so that it does not represent a binding constraint on the agent’s problem.

2. Guess initial capital stock, insurance premiums, unintended bequests and cost adjustment factor for firms offering group health insurance and use the firm’s first order conditions to compute factor prices.

3. Solve the agent’s optimization problem recursively for state contingent policy functions.

4. Using the policy functions computed in step 3, the initial distribution of agents ($\lambda_1$) and the transition matrices for productivity, medical expenditure shocks, health status, retiree insurance offers and firm type compute the distribution of agents through forward simulation.

5. Calculate the updated aggregate capital stock and unintended bequests $(K_1, B_1)$ and equilibrium conditions.

6. If the equilibrium conditions and the difference in the capital stock and unintended bequest $||(K_0, B_0) - (K_1, B_1)||$ are satisfied up to a convergence criteria of $\epsilon = 1^{-4}$ then stop; otherwise update insurance premiums, the
capital stock, unintended bequests and the cost adjustment factor and return to step 2 until convergence is achieved.