Health Insurance and Precautionary Saving: A Structural Analysis

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Abstract

Starr-McCluer (1996) documented an empirical finding showing that US households covered by health insurance saved more than those without coverage, which is inconsistent with the standard consumption-saving theory. This study conducts a structural analysis and suggests that institutional factors, particularly, a social insurance or safety net system and an employment-based health insurance system, can account for this puzzling finding. A dynamic equilibrium model is built that combines these two institutions with heterogeneous agents making endogenous decisions regarding saving, the labor supply and health insurance when they are young. The model, in which agents save in a precautionary manner, can generate Starr-McCluer’s empirical finding. The result implies that Starr-McCluer’s results are not inconsistent with the standard theory of saving under uncertainty, but it does indicate that the standard saving regression model is unable to reveal the precautionary saving motive. Counterfactual experiments are performed to provide implications for empirical analyses.

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Keywords: Precautionary Savings, Social Insurance, Employment-based Health Insurance.

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1 Introduction

Starr-McCluer (1996) argued that the standard consumption-saving theory, which implies that more insured households should save less due to precautionary motives, is inconsistent with the empirical finding that US households covered by private health insurance save more than comparable uninsured households. This paper takes a structural approach to revisit this issue and suggests that two institutions in the US, means-tested social welfare and employment-based health insurance (EHI), can account for the puzzling empirical finding documented by Starr-McCluer.

Starr-McCluer studies the impact of private health insurance on household savings in the American working-age population and tests the precautionary saving hypothesis. Although several econometric methods are applied to control for other household characteristics and factors that also affect saving, the results indicate that health insurance coverage has a significant and positive effect on savings. Table 1 presents part of the empirical results. The coefficients of health insurance coverage (labeled ‘PHI coverage’) are significant and positive in all the three regressions regardless of the measure of assets.

To conduct a structural analysis, I build a dynamic stochastic general equilibrium model where heterogeneous agents face uncertain retirement or death, idiosyncratic income and medical shocks, and make decisions regarding saving, the labor supply and health insurance. Markets are incomplete, and thus risk-averse agents in the economy have an incentive to save in a precautionary manner and to purchase health insurance. Two institutions, a social insurance (safety net) system and an employment-based health insurance system, are incorporated as key factors to examine the insurance-savings correlation. Although this study focuses on the saving-insurance decisions of the working-age population, social security and Medicare are also incorporated because they affect younger agents’ expectations of their lives after retirement.

The model, in which individuals save in a precautionary manner, can generate Starr-McCluer’s (1996) empirical finding for two reasons: 1) the social insurance system creates a strong disincentive to save (as discussed in Hubbard et al., 1995) and to purchase health insurance. However, the availability of health insurance (e.g., insurance offers from employers) reduces the likelihood of accessing social insurance, and so has a positive effect on saving; 2) health insurance status is uncertain because it is highly contingent on employment. Households currently covered by health insurance are in a good state and will save to hedge against losing insurance, a precautionary motive. This reinforces the positive insurance-savings correlation. This paper suggests that Starr-McCluer’s finding is not inconsistent with the standard theory of saving un-
Table 1: Empirical finding: regressions with various measures of assets

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Regression 1 (Liquid assets)</th>
<th>Regression 2 (Financial assets)</th>
<th>Regression 3 (Net worth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHI coverage</td>
<td>2.66*</td>
<td>2.97*</td>
<td>1.72*</td>
</tr>
<tr>
<td>Permanent Income</td>
<td>1.53*</td>
<td>1.71*</td>
<td>1.69*</td>
</tr>
<tr>
<td>Health problems</td>
<td>-0.34*</td>
<td>-0.28*</td>
<td>-0.41*</td>
</tr>
</tbody>
</table>

Source: Starr-McCluer (1996), page 290. Only selected variables are reported here. PHI coverage and Health problems are dummy variables. Other variables include age, race, gender, marital status, education, a dummy of having children and dummies of past and expected inheritance. * indicates significance at the 5% level.

The observed positive pattern is the result of the distortion from the two institutional factors. Counterfactual experiments with various institutional settings are performed, and the results indicate that the standard saving regression model cannot always reveal the true precautionary saving motive within each environment. I show that even if a perfect instrument for insurance status (i.e., a purely exogenous insurance variable) is used in the regression, the same puzzling result can be found as long as the effects of the two institutional factors, the social welfare system and the stochastic EHI, are not well controlled.

The goal of this study is to diagnose the empirical puzzle using a structural approach to provide new light on studies on related saving and insurance issues. This study contributes to the literature pioneered by Kotlikoff (1989) analyzing the effects of health expenditure shocks on precautionary savings and the literature of dynamic equilibrium models with heterogeneous agents in incomplete markets. Several recent studies have examined the impacts of health and medical expenditures in Aiyagari-Bewley type models. However, there are relatively few studies that have applied this approach to the study of health insurance programs, although Attanasio, Kitao and Violante (2010) and Jeske and Kitao (2009) are two exceptions.

The theoretical framework in this study is similar to that of Jeske and Kitao (2009), who analyze the effects of US tax policy on health insurance choices, but is differentiated from previous studies by endogenizing the health insurance decision. Attanasio, Kitao and Violante (2010) use a general equilibrium life cycle model with incomplete

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2 For example, Livshits et al. (2007) and Chatterjee et al. (2007) suggested that medical expenditure shock is an important reason for consumer bankruptcy. Palumbo (1999), De Nardi et al. (2006) and Scholz et al. (2006) studied medical expenses to understand the pattern of retirement savings.
markets, endogenous labor decisions and medical expenditure shocks to evaluate alternative financing schemes for Medicare. Health insurance coverage for young agents is not endogenized because they focus on Medicare, which serves the elderly.\footnote{The focus of this paper is on the working-age population, similar to Jeske and Kitao (2009), and a life-cycle analysis is not performed. A general equilibrium life cycle model similar to that in Attanasio, Kitao and Violante (2010) with endogenous health insurance decision is used in Hansen, Hsu and Lee (2012) to evaluate alternative health insurance reform options.}

The remainder of this paper is organized as follows: Section 2 introduces the model, and section 3 presents specifications of the model and calibration. The quantitative analysis and discussion are provided in section 4, while section 5 presents the conclusion.

2 The Model

This section describes the model settings for the benchmark economy.

2.1 General Model Environment

2.1.1 Demographics

The economy is populated by a continuum of agents (measure one) who maximize expected discounted lifetime utility from consumption and leisure. The population consists of two generations – the young (working-age) and the old (retired). Young agents supply labor and earn wage income, while old agents no longer work and receive social security benefits. Young agents retire with a probability $\rho_o$ every period, and old retired agents die and leave the economy with a probability $\rho_d$ every period. At the beginning of each period, the economy has new-born young agents replacing those old agents, who died at the end of previous period, such that the measure of total population remains constant. The demographic setting with the probabilities described above implies that the proportion of old agents in the population is $\frac{\rho_o}{\rho_o + \rho_d}$, and that of young agents, $\frac{\rho_d}{\rho_o + \rho_d}$. I do not consider the annuity market for the old in this economy and assume all bequests are accidental and distributed equally to all surviving households.

2.1.2 Idiosyncratic Shocks

Labor productivity shock and uncertain insurance offer

Young agents’ effective labor supply depends on the hours worked and a stochastic idiosyncratic labor productivity shock $z$. In each period $t$, the idiosyncratic labor productivity shock takes a value in a finite set $Z = \{z_1, z_2, ..., z_n\}$. Old agents retire from the
labor market and therefore do not encounter any labor shocks (assuming their \( z \) is fixed at 0).

Employers may offer health insurance, \( e \in \{0, 1\} \), together with a job offer (represented by \( z \)). The processes of \( z \) and \( e \) are assumed to follow a joint Markov transition matrix \( \Pi_{(z',e')|(z,e)} \). The health insurance structure will be further discussed in Section 2.3.

**Medical expenditure shock**

Both young and old agents face medical expenditure shocks \( x \). In each period \( t \), each agent’s medical expenditure shock takes a value in a finite set \( X_i = \{x_{1,i}, x_{2,i}, \ldots, x_{m,i}\} \) for \( i \in \{o, y\} \), representing the old and the young, respectively. Each agent’s medical expenditure shock evolves independently according to a first-order Markov process with a transition probability matrix \( P_{(x'|x)}^i \) and an invariant distribution \( \pi_{x,i} \) for \( i \in \{o, y\} \).

2.1.3 **Production Technology**

On the production side, we assume that there is a continuum of competitive firms operating a technology with constant returns to scale. Aggregate output \( Y \) is given by

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

where \( K \) and \( L \) are the aggregate capital and effective labor employed by the firm’s sector and \( A \) is the total factor productivity. Capital depreciates at the rate of \( \delta \) every period. \( \theta \) denotes the capital income share.

2.1.4 **Preferences**

I adopt a standard utility function \( u(c, n) \) that is consistent with a balanced growth path and is widely used in the growth literature, as shown below:

\[
u(c, n) = \frac{c^\phi (1-n)^{1-\phi}}{1-\mu}^{1-\mu}, \quad (1)
\]

where \( \phi \) determines the relative preference for consumption versus leisure, and \( \mu \) governs the intertemporal elasticity of substitution for consumption. The relative risk aversion coefficient is given by \( \gamma = 1 - \phi + \phi \mu \) (see Heathcote, Storesletten and Violante, 2008, for a detailed discussion on the properties of the utility function). Alternative utility functions will be discussed in Appendix A6.
2.1.5 Asset Market

Individuals can hold assets and thus partially insure themselves against income or expenditure uncertainties by accumulating precautionary asset holdings. While they are allowed to insure themselves by accumulating positive asset holdings, borrowing is limited to reflect market incompleteness in the real world.

The assets of those who die and leave the economy are assumed to be equally distributed to all survivors as a bequest (denoted by $b$).

2.2 Government and Social Programs

Government revenue consists of revenues from different tax instruments, such as labor income tax $\tau_n$, capital income tax $\tau_k$, consumption tax $\tau_c$ and Social Security tax $\tau_{ss}$. The social security tax $\tau_{ss}$ is imposed on young agents’ labor income.

The government runs three social programs: Social Security, Medicare, and means-tested social insurance (safety net).

**Social Security**

The Social Security program provides old agents with benefits $ss$. As shown below, it is self-financed by the Social Security tax revenue:

$$\int (ss)d\Phi(s) = \int \tau_{ss}(wzn)d\Phi(s),$$

(2)

where $\Phi(s)$ is the distribution of the population over state space $s$.

**Medicare**

Medicare is a public program through which the government provides health insurance for the elderly. Once agents become retired in the model, they are automatically covered by Medicare. Medicare covers a fraction $\omega_o(x)$ of realized medical expenditures $x$ and is financed by a combination of general government revenue and a Medicare premium $q_{med}$ from each old agent.

**Social insurance**

The asset-based, means-tested social insurance system enables households to maintain a minimum consumption level (denoted by $c$) that the government would like to guarantee. I employ a simple rule for the operation of the social insurance system similar to that used by Hubbard et al. (1995): if a household’s disposable income and assets $H$ (net after medical expenditure) are lower than $c$, the household qualifies for and will receive
social-insurance benefits (a transfer payment) to the extent that households can have at least \( C \) cash on hand to spend.\(^4\)

Social insurance payments, Medicare and other government expenditures are financed by the revenue earned from the labor income tax \( \tau_n \), the capital income tax \( \tau_k \), the consumption tax \( \tau_c \) and Medicare premiums \( q_{med} \):

\[
G + \int [TR + \omega_b(x)x]d\Phi(s) = \int [\tau_n(wn) + \tau_k(a + b) + \tau_c + q_{med}]d\Phi(s),
\]

where \( TR \) is the amount of financial transfer from the social insurance system, \( x \) is individual medical expenditures, \( a \) denotes the individual asset holdings, \( b \) represents accidental bequests, \( G \), which represents all other government expenditures, is a residual to balance the budget and \( \Phi(s) \) is the distribution of population over the state space.

### 2.3 Private Health Insurance

To characterize the current American health insurance market, two types of private health insurance (PHI) are incorporated in the model: employment-based health insurance (EHI) and individual health insurance (IHI). The former, which is offered by employers and required by law not to discriminate among individuals on the basis of health, is also called a group health insurance. In the latter, insurance companies have an incentive to price-discriminate.

Everyone has access to IHI, but EHI is available only if it is offered by the employer. I use \( e \) to denote the EHI offer status. EHI’s premium, \( q_e \), does not depend on individual statuses. If EHI is offered \( (e = 1) \), the premium cost is partially shared by the employer (with a share \( \varepsilon_e \)) but an amount \( \varepsilon_e q_e \) will be deducted from employees’ wages to ensure the firm’s break-even condition. If an agent decides to accept the EHI offer at the beginning of a period, a fraction \( \omega_e(x') \) of the realized medical cost \( x' \) in this period will be covered by the EHI.

If an agent is not offered an EHI \( (e = 0) \) or declines the EHI offer, the agent can still purchase an IHI contract to cover medical shocks. A premium \( q_p(x) \), which depends on the agent’s initial health status (i.e. previous medical expenditures) \( x \), must be paid at the beginning of the period before the medical shock of this period \( x' \) is realized. The status-dependent insurance premium reflects actual price discrimination in the IHI market.

Health insurance companies are assumed to be risk-neutral and competitive, and to be able to monitor each agent’s medical expenditures. It is assumed that there is no

\(^4\)This simple social insurance system is used to characterize the social programs with means tests and asset restrictions in the US, such as Aid to Families with Dependent Children (AFDC), Medicaid, Supplemental Security Income (SSI) and food stamps.
cross-subsidy across contracts. The premium for an insurance contract offered to an individual whose previous medical expenditure was $x$ satisfies the following condition:

$$q_p(x) = (1 + \psi) E [\omega_p(x') \cdot x' | x],$$

(4)

where $\omega_p(x) \in [0, 1]$ denotes a proportion of total medical expenditure ($x$) covered by the insurance and $\psi$ denotes a proportional mark-up.
2.4 Agent’s Problem

2.4.1 The Time Line of Decisions

Each model period contains two stages of shock realization and decision making. At the beginning of each period (stage 1), agents observe the asset holdings from the last period $a$, the labor productivity $z$, EHI offer $e$, the last period’s medical expenditures $x$, and decide whether to take up the EHI (if $e = 1$) or to purchase a private insurance contract IHI before the current period’s medical shock $x'$ is realized. $i_{HI}$ is an indicator that denotes the insurance decision. After the insurance decision is made (stage 2), the medical expenditure shock $x'$ is realized and households make decisions on consumption $c$, labor supply $n$ and asset holdings $a'$. Figure 1 illustrates the process of shock realization and decision making at time $t$ in the model.

2.4.2 Young Agent’s Problem

The state can be summarized by a vector $s = (a, z, e, x)$ when a young agent makes the insurance decision. Then, additional information on $x'$ is available for forming expectations and other economic decisions. A young agent’s problem can be expressed as the following:

![Figure 1: Time line of shock realization and decision making](image-url)
\[
V(s) = \max_{i_{HI}} \left\{ \sum_{x'} P_{(x'|s)} \max_{c,n,a'} \left\{ u(c,n) + \beta \left( (1 - \rho_d) E[V(s')|s,x'] + \rho_d E[V_o(s')|s,x'] \right) \right\} \right\}
\]

(5)

subject to

\[
(1 + \tau_c)c + a' + \hat{q} = Wel_v + TR
\]

(6)

\[
Wel_v \equiv (1 - \tau_{ss} - \tau_o) \hat{L} + [1 + (1 - \tau_k) a] - [1 - \hat{\omega}] x'
\]

(7)

\[
\hat{L} = \begin{cases} 
    wz_{n} & \text{if } e = 0 \\
    wz_{n} - \varepsilon e q_{e} & \text{if } e = 1 \\
    0 & \text{if } i_{HI} = 0 \\
    (1 - \varepsilon e) q_{e} & \text{if } e = 1 \text{ and } i_{HI} = 1 \\
    q_{p}(x) & \text{if } i_{HI} = 2
\end{cases}
\]

(8)

\[
\hat{q} = \begin{cases} 
    0 & \text{if } i_{HI} = 0 \\
    \omega_{e}(x') & \text{if } e = 1 \text{ and } i_{HI} = 1 \\
    \omega_{p}(x') & \text{if } i_{HI} = 2
\end{cases}
\]

(9)

\[
\hat{\omega} = \begin{cases} 
    0 & \text{if } i_{HI} = 0 \\
    \omega_{e}(x') & \text{if } e = 1 \text{ and } i_{HI} = 1 \\
    \omega_{p}(x') & \text{if } i_{HI} = 2
\end{cases}
\]

(10)

\[
TR = \max\{0, (1 + \tau_c)z - Wel_v \}
\]

(11)

\[
i_{HI} \in \{0, 1, 2\}; \quad a' \geq 0; \quad 0 \leq n < 1;
\]

(12)

where \(V_o\) is the value when the agent retires; \(\hat{L}\) denotes labor income, \(\varepsilon_e\) is the employer’s share of the EHI premium and \(TR\) is the transfer from the social insurance system; \(i_{HI}\) is an indicator that takes a value of 1 if the agent accepts the EHI offer (if \(e = 1\)), a value of 2 if the agent purchases private individual health insurance, and 0 otherwise.

### 2.4.3 Old Agent’s Problem

For the retired agents, labor productivity \(z\) and the EHI offer \(e\) are both fixed at 0. They supply no labor and receive Social Security payment \(ss\) as their main income source. Therefore, they encounter medical shocks without income uncertainty. All retired agents are assumed to be automatically enrolled in Medicare. With Medicare coverage, the out-of-pocket medical expenditure is \([1 - \omega_o(x)]x\) out of the realized total medical cost \(x\).

An old agent’s problem is given as

\[
V_o(s) = \sum_{x'} P_{(x'|s)} \max_{c,a'} \left\{ u(c,1) + \beta (1 - \rho_d) E[V_o(s')|s,x'] \right\}
\]

(13)
subject to

\[(1 + \tau_c)c + a' = Wel_o + TR\]  \hspace{1cm} (14)

\[Wel_o \equiv ss + [1 + (1 - \tau_k)](a + b) - \left[1 - \omega_o(x')\right]x' - q_{med}\]  \hspace{1cm} (15)

\[TR = \max\{0, (1 + \tau_c)c - Wel_o\}\]  \hspace{1cm} (16)

\[a' \geq 0.\]  \hspace{1cm} (17)

### 2.5 Recursive Competitive Equilibrium

A stationary recursive competitive equilibrium consists of individual decision rules of asset holding \(a'\), labor supply \(n\), health insurance take-up \(i_{HI}\) and consumption \(c\), as well as a set of firm decisions regarding capital rented \(K\) and effective labor employed \(L\), a price system of \(w\) and \(r\), EHI’s expenditure coverage ratio \(\omega_o\), premium \(q_e\) and the employer’s share \(\varepsilon_e\), private IHI expenditure coverage ratio \(\omega_p\) and premium \(q_p\), a government policy of tax rates \(\{\tau_n, \tau_k, \tau_c\}\), government expenditure \(G\), a Medicare policy \(\{\omega_o, q_{med}\}\), a social insurance policy \(\{ss, \tau_{ss}\}\), a lump-sum transfer of accidental bequests \(b\) and a stationary distribution of population over the state space \(\Phi(s)\), such that:

**a)** given the price system, EHI premium and employer’s share, the decision rules of \(K\) and \(L\) solve the firm’s profit maximization problem;

**b)** given the price system, health insurance plans, accidental bequests and government policies, the decision rules of \(\{i_{HI}, a', n, c\}\) solve young and old agents’ problems;

**c)** insurance companies are competitive. The IHI premium satisfies condition (4), and the EHI premium satisfies:

\[q_e = \frac{\int E[\omega_o(x')x'|i_{HI}]\Phi(s)ds}{\int (i_{HI})\Phi(s)ds} \ldots (18)\]

**d)** the government policies satisfy the government’s budget constraints (2) and (3);

**e)** all markets clear: \(L = \int (zn)\Phi(s)ds\) and \(K = \int (a + b)\Phi(s)ds\);

**f)** the resource feasibility condition is satisfied:

\[Y + K = C + X + G + K' - \delta K,\]

where \(C\) is the aggregate consumption \(C = \int (c)\Phi(s)ds\) and \(X\) is the aggregate medical expenditure \(X = \int (x)\Phi(s)ds\).
3 Model Specification and Calibration

To solve the model numerically and provide an adequate quantitative analysis, I begin by describing the calibration and parameterization of the model. A summary of the parameters is presented in Table 2.

Table 2: Summary of parameters for the benchmark economy

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Values</th>
<th>Target/Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preferences</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\beta$</td>
<td>discount factor</td>
<td>0.96</td>
<td>capital-output ratio = 3</td>
</tr>
<tr>
<td>$\mu$</td>
<td>utility parameter</td>
<td>3</td>
<td>implied relative risk aversion = 2.2 / Frisch elasticity = 0.49</td>
</tr>
<tr>
<td>$\phi$</td>
<td>leisure utility parameter</td>
<td>0.60</td>
<td>aggregate labor hours = 0.34</td>
</tr>
<tr>
<td>Technology and production</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\theta$</td>
<td>capital income share</td>
<td>0.33</td>
<td></td>
</tr>
<tr>
<td>$\delta$</td>
<td>depreciation rate of capital</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>Demographics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\rho_o$</td>
<td>probability of aging/retiring</td>
<td>0.0222</td>
<td>average years worked = 45</td>
</tr>
<tr>
<td>$\rho_d$</td>
<td>probability of death after retirement</td>
<td>0.0889</td>
<td>share of old population = 0.2</td>
</tr>
<tr>
<td>Government</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\tau_c$</td>
<td>consumption tax rate</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>$\tau_n + \tau_{ss}$</td>
<td>total labor tax</td>
<td>0.35</td>
<td></td>
</tr>
<tr>
<td>$\tau_k$</td>
<td>capital tax</td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>$ss$</td>
<td>Social Security payment</td>
<td>45%</td>
<td>of average earnings</td>
</tr>
<tr>
<td>$g$</td>
<td>social insurance consumption floor</td>
<td>15%</td>
<td>of GDP per capita</td>
</tr>
<tr>
<td>Health insurance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$q_{med}$</td>
<td>Medicare premium</td>
<td>12%</td>
<td>of average Medicare cost</td>
</tr>
<tr>
<td>$\psi$</td>
<td>PHI premium markup</td>
<td>0.065</td>
<td>IHI coverage ratio = 3.2%</td>
</tr>
</tbody>
</table>

3.1 Demographics

The model period is one year. The economy is populated by a continuum of agents (measure one) who maximize expected discounted lifetime utility from consumption
and leisure. The population consists of two generations – the young and the old. Young agents represent those aged between 20 and 64, and old agents are those aged 65 and above. Young agents retire with a probability $\rho_o$, and therefore, on average, young agents work for $(1/\rho_o)$ years. The retirement probability $\rho_o$ is set at $1/45$ so that workers remain in the labor force for an average of 45 years. After withdrawing from the labor market, the old die and leave the economy with a death probability of $\rho_d$. The death probability $\rho_d$ is set such that old agents constitute 20% of the population in accordance with the data from the Medical Expenditure Panel Survey (MEPS) as shown in Jeske and Kitao (2009). New young agents enter the economy in each period, balancing the deaths of old agents for a constant total population.

### 3.2 Social Insurance

To characterize the means-tested social insurance system, it is necessary to measure the consumption floor ($c$) that the government attempts to guarantee, above and beyond medical expenses, through means-tested transfer payments. Hubbard et al. (1995) make the first approximation by calculating the consumption floor for a representative US family. Their estimate includes only asset- and means-tested transfer payments, such as Aid to Families with Dependent Children (AFDC), food stamps, and Section 8 housing assistance for those under age 65. Unemployment insurance is not included because it is not means-tested, and because it is already included in the measure of income. Medicaid (for the poor) is part of the means-tested social insurance system, but it should not be included in $c$ because it is used exclusively to pay for medical expenses.\(^5\)

Their estimation suggests that for a female-headed family with two dependent children and no outside earnings or assets, the median AFDC and food stamp transfers ($5,764) plus expected housing subsidies ($1,173) were $6,937 in 1984. In terms of a per person subsidy ($6,937/3$), it constituted approximately 14% of GDP per capita in 1984 (which is $16,549). As mentioned by Hubbard et al., the total benefit may change significantly with a different household condition (e.g., if there is a father in the household). Therefore, $c$ is chosen to be 15% of GDP per capita in the benchmark model ($5,729 in 2003), and alternative values from 1% to 35% will also be evaluated.

\(^5\)In the model, medical payments are included in the transfer payments, $TR$, made by the social insurance system. However, by definition, medical payments should not be included in $c$. $TR$ has two components, and can be expressed as follows: $TR = c - H = (c - (1 - \tau_s - \tau_k)I) - [1 + (1 - \tau_k)r(a + b)] + X$, financial support for a minimum consumption standard and support for medical care.
3.3 Preferences and Production Technology

The utility parameter $\mu$ is set at 3. The consumption/leisure utility parameter $\phi$ is chosen so that aggregate labor hours are roughly one-third in the benchmark economy. The above setting implies that the relative risk aversion coefficient $\gamma$ is 2.2, which is roughly in the middle of the estimates (between one to three) suggested in the empirical consumption literature (see Attanasio, 1999, for a survey). The Frisch elasticity of labor supply depends on labor hours, $\phi$ and $\mu$: $\lambda(n, \phi, \mu) = \zeta \frac{1-n}{n}$, where $\zeta = \frac{1-\phi+\phi\mu}{\mu}$. As discussed in Heathcote, Storesletten and Violante (2008), a “non-stochastic Frisch” elasticity of labor supply corresponding to a non-stochastic version of the model is defined as $\bar{\lambda} = \zeta (1-\phi)/\phi$, which is 0.49 given the selection of $\phi$ and $\mu$. The implied Frisch elasticity here is close to that used in Heathcote, Storesletten and Violante, as a compromise between the low estimates for males and high estimates for females.\(^6\) Alternative utilities are discussed in Appendix A6. The utility discount factor ($\beta$) is chosen so that the capital-output ratio is close to 3.

In the production function, the capital income share ($\theta$) is set at 0.33 and the depreciation rate of capital ($\delta$) is set at 0.06. Total factor productivity $A$ is normalized to unity. The above parameter values are chosen to be consistent with aggregate features of the postwar US economy and are commonly used in aggregative models of growth and business cycles.

3.4 Labor Productivity and EHI Offer Uncertainties

In the model, the labor productivity shock ($z$) process is used to capture wage rate fluctuations because labor supply is endogenous in the model. Variables ‘hrwg31x’ ‘hrwg42x’ ‘hrwg53x’ in the MEPS database record hourly wages for three subperiods in a year. I use the average of the three variables to construct a measure of annual labor productivity. Only household heads are studied in this paper. The definition of a household head is the person with the highest wage income (variable ‘wagep\_yy’ in year yy) in a Health Insurance Eligibility Unit (HIEU). I use three 2-year panels from 2001 to 2004 and all nominal values are converted to 2003 dollar values.

The procedure of calibrating the labor productivity shock $z$ and the joint transition of $z$ and the EHI offer $e \in \{0, 1\}$ is similar to that used in Jeske and Kitao (2009). I specify the wage distribution over five states, which represent (25%, 25%, 25%, 20%, 5%) of the wage distribution from the bottom to the top. The uneven grid points are constructed to capture the long right tail of the wage distribution. The five $z$ states relative to the average hourly wage are $Z = \{0.138 \ 0.638 \ 1.089 \ 1.865 \ 3.206\}$. The statuses of EHI

\(^6\)One can see their discussion on the selection of Frisch elasticity in their 2008 paper.
offers (through a current main job) in three subperiods of a year are recorded in variables ‘offer31x’, ‘offer42x’ and ‘offer53x’ in the MEPS database. I classify an individual as having an EHI offer ($e = 1$) if he or she had an offer for at least one subperiod in a year, and $e = 0$ otherwise. A joint $(z, e)$ transition matrix is calibrated according to the distribution and the transition in the three 2-year panels. The details of the calibration are described in Appendix A1.

### 3.5 Medical Expenditure Shocks

To characterize medical expenditure shocks, a Markov process is used directly instead of an AR(1) process because of the skewedness of medical expenditures. I define four medical expenditure states as “low,” “fair,” “high,” and “very high,” which represent the medical expenditures of the bottom 60%, from 60 to 95%, from 95 to 99%, and the top 1%, respectively. Jeske and Kitao (2009) have analyzed the distribution of medical expenditures and estimated the process of medical expenditures based on the MEPS. Based on their report, I calculate the mean medical expenditures of each medical expenditure group in the US working-age and retired populations in 2003. These expenditures were 0.9%, 10.8%, 50.0%, and 159.4% of the average income in 2003 for the four expenditure groups in the working-age population, respectively, and were 4.9%, 28.5%, 103.6%, and 226.5% of the average income in the retired population. Therefore, I set the four-state medical expenditure shocks, $X_y$ and $X_o$ for the young and the old respectively, as the above percentages of average labor income in the model (see Table 3).

Monheit (2003) uses the 1996/97 MEPS data to study the persistence of medical expenditures. Jeske and Kitao (2009) also use the MEPS data to determine the transition probabilities of medical expenditure states. In this study, the transition probabilities for the Markov chain of medical expenditures are calibrated based on the estimation from Jeske and Kitao (2009). See Appendix A2 for the detailed transition probabilities.

### 3.6 Health Insurance

Based on the MEPS, private health insurance provides various expenditure coverage rates depending on policy holder’s the age and amount of medical expenditures. I use the report provided in Jeske and Kitao (2009) to set the expenditure coverage rates of PHI (both IHI’s $\omega_p(x)$ and EHI’s $\omega_e(x)$) as (.528 .702 .765 .845) for young agents’ four medical expenditure states, respectively, and set Medicare’s $\omega_o(x)$ as (.315 .511 .637 .768) for old agents’ four medical expenditure states. Every old agent is assumed to be enrolled in Medicare. According to the Kaiser Family Foundation’s report, Medicare: A Primer 2010, Medicare premiums make up only 12% of total Medicare expenditures.
Table 3: Status of medical expenditure

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>bottom 60%</td>
<td>310</td>
<td>0.9%</td>
</tr>
<tr>
<td>Fair</td>
<td>60 – 95%</td>
<td>3,597</td>
<td>10.8%</td>
</tr>
<tr>
<td>High</td>
<td>95 – 99%</td>
<td>16,629</td>
<td>50.0%</td>
</tr>
<tr>
<td>Very High</td>
<td>top 1%</td>
<td>53,013</td>
<td>159.4%</td>
</tr>
</tbody>
</table>

The old (X_o)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>bottom 60%</td>
<td>1,630</td>
<td>4.9%</td>
</tr>
<tr>
<td>Fair</td>
<td>60 – 95%</td>
<td>9,474</td>
<td>28.5%</td>
</tr>
<tr>
<td>High</td>
<td>95 – 99%</td>
<td>34,455</td>
<td>103.6%</td>
</tr>
<tr>
<td>Very High</td>
<td>top 1%</td>
<td>75,329</td>
<td>226.5%</td>
</tr>
</tbody>
</table>

Original source: MEPS.

This ratio (12%) of total Medicare cost is used for setting the premium \( q_{med} \) in the model.

The PHI serves as the primary insurance in the benchmark economy. The markup \( \psi \) of PHI in the benchmark economy is chosen so that the IHI coverage in the model can match the data. I define IHI coverage as a sum of nongroup insurance coverage, self-employed insurance and source-unknown private insurance coverage in the MEPS data. According to this definition, the average IHI coverage in 2001–2004 is 3%. Therefore, the corresponding \( \psi \) is 0.065 in the benchmark model. A detailed description of the insurance coverage data is provided in Appendix A3.

### 3.7 Social Security and Government Taxation

The social security payment is set at 45% of average labor income according to a study by Whitehouse (2003). Based on Imrohoroğlu and Kitao (2009 and 2010), the consumption tax rate is set at 5%, the capital income tax is 30% and the total labor income tax rate is 35% (which includes the Social Security tax and Medicare tax).
4 Quantitative Analysis

The model is solved for its steady-state equilibrium, and simulations are performed for quantitative analysis. This section first describes the equilibrium features in the benchmark economy and demonstrates that Starr-McCluer’s empirical finding is generated by the model.\(^7\)

The model, which has risk-averse agents with a precautionary saving motive, suggests that the social insurance and the stochastic EHI coverage can account for the positive insurance-savings correlation. Counterfactual experiments are performed to understand the roles of the two institutions. The implications for empirical tests are also discussed.

4.1 Is a Positive Insurance-Saving Correlation Puzzling?

4.1.1 Features of the Benchmark Economy

The benchmark economy represents the US economy, particularly the features of its health insurance market. The model is calibrated to match the capital-output ratio, average labor supply and IHI coverage ratio across the working-age population. The aggregate features of the benchmark are listed in Table 4.

Table 4 also compares asset holdings by health insurance type for insured versus uninsured agents (whose asset holdings are normalized to one). Those covered by EHI hold an average of 85% more assets than the uninsured, and those covered by IHI hold 51% more. Consequently, the unconditional means have shown that young agents who have insurance coverage (from EHI or IHI) save more than those without insurance coverage.

The majority of PHI is employment-based, which is a feature of the US health insurance market. In the model, EHI take-up is endogenous given the EHI offer process. If EHI is offered, most individuals (93%) will accept it (see the last column of Table 5) because EHI premiums are highly subsidized by employers. It is slightly higher than the take-up rate in the MEPS data (91%). Therefore, EHI coverage among the young in the model (61%) is slightly higher than the 60% in the data. IHI coverage is matched to the data (3%) due to the calibration of the proportional markup parameter $\psi$.

In addition, PHI coverage generally increases by income level. PHI coverage ratios

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\(^7\)Given the equilibrium prices, the solved individual decision rules and shock processes are adopted to simulate an individual’s period choices for 200,000 rounds. The first 15,000 observations are discarded to prevent the bias caused by the initial condition, and the remaining observations are used to approximate the cross-sectional distribution in the economy.
over four labor income groups in both the model and the data are presented in Figure 2. This pattern is primarily driven by the greater probability of receiving an EHI offer with a better job position (i.e., a higher labor productivity level in the model). I also show EHI take-up ratios over labor income groups in both the model and the data in Figure 3.

Figure 2: PHI coverage (over earnings)

![Figure 2: PHI coverage (over earnings)](image)

Figure 3: EHI take-up ratio when offered (over earnings)

![Figure 3: EHI take-up ratio when offered (over earnings)](image)

Table 4: Benchmark: aggregate features

<table>
<thead>
<tr>
<th>Capital to output ratio</th>
<th>Interest rate</th>
<th>Labor hours</th>
<th>G/Y ratio</th>
<th>Asset holdings ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>dPHI/aun</td>
</tr>
<tr>
<td>3</td>
<td>4.78%</td>
<td>0.34</td>
<td>28.7%</td>
<td>1.85</td>
</tr>
</tbody>
</table>

Note: $a_i/a_{un}$ is the ratio of average asset holdings of agents covered by the $i$ type insurance to that of the uninsured. $G$ government consumption is defined as a residual that balances the government budget constraint.
### Table 5: Benchmark: health insurance features

<table>
<thead>
<tr>
<th>PHI coverage</th>
<th>EHI coverage</th>
<th>IHI coverage</th>
<th>EHI take-up (if offered)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>64%</td>
<td>61%</td>
<td>3%</td>
</tr>
<tr>
<td>Data</td>
<td>63%</td>
<td>60%</td>
<td>3%</td>
</tr>
</tbody>
</table>

Notes: PHI includes EHI and IHI. Coverage is the ratio of the insured among working-age population.

### Table 6: Regression result: benchmark

<table>
<thead>
<tr>
<th>Explanatory variable</th>
<th>PHI coverage</th>
<th>Permanent income</th>
<th>Health problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coefficient</td>
<td>3.66</td>
<td>1.53</td>
<td>−0.59</td>
</tr>
</tbody>
</table>

All coefficients are significant at the 5% level.

#### 4.1.2 Empirical Testing

Although the statistics of mean asset holdings show that the insured save more than the uninsured, to identify the effect of private health insurance on savings exclusively and to test the precautionary saving hypothesis, empirical studies use econometric methods that control for other characteristics. I follow this approach with the model, and therefore I am able to provide a comparison with the existing empirical findings in the literature, which has implications for empirical studies on precautionary savings.

I use data generated from model simulations for the regressions (with a sample size of 185,000 observations for each regression). The regression model is set as follows:

\[ a_i = \alpha PHI_i + \beta' Q_i + \epsilon_i, \]  

(19)

where \( a_i \) is a young agent \( i \)'s asset holdings, \( PHI_i \) is a dummy variable for private health insurance coverage, and \( Q_i \) is a vector of variables that controls for all other directly observable household characteristics also affecting saving.\(^8\) According to the standard consumption-saving model, a negative coefficient of \( PHI \) (i.e., \( \alpha < 0 \)) would be interpreted as verification of the existence of precautionary saving.

I have attempted to create a regression that is close to the regression used in Starr-McCluer, although there are fewer variables I can use in the model. I follow Starr-McCluer to estimate ‘permanent income’ instead of ‘current income’ as an independent variable in the regression. Because current income is more endogenous, it is unlikely to

---

\(^8\)See the control variables used in Starr-McCluer (1996), for example.
be an appropriate independent variable in the savings regression. The idea is to estimate an individual’s permanent income, which is determined by some individual characteristics and is more exogenous, and to assume that current income is determined by permanent income and a transitory component. I follow the method of constructing permanent income from cross-section data used in Starr-McCluer with some simplifications (e.g., the model does not have different cohorts, and therefore the cohort effect variable is not included in the estimation). The details are provided in Appendix A4.

In addition to permanent income, Starr-McCluer also controls for health status in the regression model. She uses a self-reported indicator (a dummy), namely, whether any household members have persistent health problems, as a measure. I am restricted to exogenous shocks of medical expenditures in the model. To construct a similar measure, I assume that if an individual’s medical expenditures are not more than 10.8% of average income or $3597 (i.e., the lowest two expenditure levels in the model), he or she will answer “no,” in which case the indicator has a value of zero; otherwise, the individual will answer “yes,” in which case the indicator has a value of one.\(^9\)

The regression result for the benchmark economy is reported in Table 6. The coefficient of PHI coverage (including EHI and IHI) is also significantly positive and consistent with Starr-McCluer’s findings. However, the interpretation of the results based on the model differs significantly from the conventional interpretation in that a significant and positive coefficient of health insurance in the above regression implies a rejection of the existence of precautionary saving.

As shown in the above exercise, in the model economy, the regression model is unable to actually reveal the existence of precautionary savings in an economy with a social insurance system and an employment-based health insurance system.

### 4.1.3 The Mechanism

The reason for the invalidity of the empirical test is that the regression model can only capture the net saving effect of health insurance, rather than the exclusive effect on precautionary saving.

As discussed in Hubbard et al. (1995), the social insurance system creates a strong disincentive to save because it reduces the risk as well as the need for precautionary savings, particularly among low-income agents. For the same reason, social insurance also substitutes for the service provided by PHI, and therefore creates a positive correlation of PHI take-ups and savings by reducing both. In addition, the availability of health

\(^{9}\) The results do not change much quantitatively from the cases, in which medical expenditures are directly used as a measure of health status (in model economies)
insurance coverage (e.g., EHI from employers) moderates the fluctuation of disposable resources caused by medical expenditure shocks, thus reducing the likelihood of accessing the social insurance that increases the expected return of asset holdings and leads to a positive effect on savings.

The nature of EHI also creates a positive correlation between insurance coverage and savings. Because the EHI offer is uncertain (highly contingent on employment and income status) and mean-reverting, agents currently covered by health insurance are in a good state and will therefore save for a precautionary motive to smooth their consumption in case they move to the bad state without EHI.

In what follows, I further diagnose the failure of the standard regression model by performing counter-factual experiments. Implications of this model for assessing empirical approaches to testing the precautionary saving hypothesis will also be discussed.

### 4.2 Implications for Empirical Testing – The Role of Institutions

It is natural to ask in what condition a regression model like the one above is appropriate for testing precautionary saving. In this subsection, counterfactual experiments are performed to examine the role of each institutional factor that can affect the insurance-savings patterns.

**Table 7: Experiments**

<table>
<thead>
<tr>
<th></th>
<th>$K/Y$ ratio</th>
<th>Labor hours</th>
<th>PHI cov.</th>
<th>EHI cov.</th>
<th>IHI cov.</th>
<th>EHI take-up (offered)</th>
<th>Assets (ratio to $a_{un}$)</th>
<th>$a_{PHI}$</th>
<th>$a_{EHI}$</th>
<th>$a_{IHI}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A)</td>
<td>3.0</td>
<td>0.34</td>
<td>64%</td>
<td>61%</td>
<td>3%</td>
<td>93%</td>
<td>1.85</td>
<td>1.87</td>
<td>1.51</td>
<td></td>
</tr>
<tr>
<td>(B)</td>
<td>3.6</td>
<td>0.39</td>
<td>89%</td>
<td>64%</td>
<td>25%</td>
<td>98%</td>
<td>0.81</td>
<td>0.94</td>
<td>0.49</td>
<td></td>
</tr>
<tr>
<td>(C)</td>
<td>2.9</td>
<td>0.38</td>
<td>61%</td>
<td>61%</td>
<td>–</td>
<td>–</td>
<td>0.98</td>
<td>0.98</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>(D)</td>
<td>3.1</td>
<td>0.34</td>
<td>66%</td>
<td>66%</td>
<td>–</td>
<td>–</td>
<td>1.49</td>
<td>1.49</td>
<td>–</td>
<td></td>
</tr>
</tbody>
</table>

Notes: (A) benchmark; (B) removing the social welfare (to a minimum $\zeta = .01$); (C) removing the uncertainty of EHI (fixed insurance status); (D) insurance status is fully exogenous (but stochastic). PHI includes EHI and IHI. $a_{un}$: average asset holdings of uninsured individuals.

#### 4.2.1 Counterfactual Experiment: Eliminating Social Insurance

Because the existence of the social insurance decreases the incentive for both precautionary saving and purchasing health insurance, the observed or estimated relation between savings and insurance coverage can be distorted. The counterfactual experiment is intended to show how saving and insurance decisions will change if social insurance
<table>
<thead>
<tr>
<th>Explanatory variable</th>
<th>Experiments (A)</th>
<th>(B)</th>
<th>(C)</th>
<th>(D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent income</td>
<td>1.53</td>
<td>1.18</td>
<td>1.76</td>
<td>1.62</td>
</tr>
<tr>
<td>Health problems</td>
<td>-0.59</td>
<td>-0.78</td>
<td>-0.41</td>
<td>-0.99</td>
</tr>
<tr>
<td>PHI coverage</td>
<td>3.66</td>
<td>-4.73</td>
<td>-0.16</td>
<td>1.81</td>
</tr>
</tbody>
</table>

Notes: (A) benchmark; (B) removing the social welfare (to a minimum $\zeta = 0.01\bar{y}$); (C) removing the uncertainty of EHI (fixed insurance status); (D) insurance status is fully exogenous (but stochastic). All coefficients are significant at the 5% level.

is removed and replaced by a minimum consumption floor of 1% of GDP per capita $\zeta = 0.01\bar{y}$, with all other parameters and institutions unchanged.

The result is presented in the second row, case (B), of Table 7. It is not difficult to see significant increases in both insurance purchasing and savings (a higher $K/Y$ ratio, 3.6, and a higher PHI coverage ratio, 89%). The uninsured also need to accumulate more precautionary savings because they cannot rely on social welfare. The labor supply also increases for more savings. The ratio of asset holdings of the insured to assets of the uninsured becomes less than one and consistent with the standard expectation based on the theory of precautionary saving.

The same regression is performed in this economy, and the result is shown in column (B) in Table 8. The PHI coverage now has a negative coefficient, which indicates the precautionary savings motive.

### 4.2.2 Counterfactual Experiment: Eliminating the Uncertainty of Health Insurance Coverage

In this experiment, health insurance coverage is predetermined and fixed for an agent’s whole lifetime. The insurance status is purely exogenous without uncertainty in this case. To construct the experiment, I turn off the IHI option and assume insurance coverage is fully determined by the EHI offer. The uncertainty of EHI offer is also turned off, and the transition matrix of $z$ and $e$ is rearranged for this purpose:

$$
\bar{\Pi}_{(z',e')|(z,e)} = \begin{bmatrix}
\Pi_{(z'|z)}^{11} + \Pi_{(z'|z)}^{10} & 0 \\
0 & \Pi_{(z'|z)}^{01} + \Pi_{(z'|z)}^{00}
\end{bmatrix},
$$
where $\Pi_{(z,e)}$ is the original $(z,e)$ transition probabilities given $(e,e') = (i,j)$ and $\mathbf{0}$ is a $5 \times 5$ matrix with zeros. With the new transition matrix $\tilde{\Pi}_{(z',e')|(z,e)}$, an individual will face the same labor productivity $z$ transition, given the current $(z,e)$ status, but the EHI status $e$ will be fixed at the current status. The initial distribution of health insurance (EHI) coverage is set equal to the steady state of the benchmark model. All other parameters and social welfare are kept the same as in the benchmark.

The result of the experiment is presented in row (C) of Table 7. In this economy, individuals currently covered by health insurance do not need to worry about the uncertainty of insurance coverage, and can therefore reduce their levels of precautionary savings compared to their levels in the benchmark. In contrast, the uninsured have no chance to receive an insurance coverage in the future, and need to maintain their savings to guard against possible medical expenditures. In the benchmark, individuals can consume their savings when they lose their EHI (i.e., in bad times) and then rebuild their savings when they receive an EHI offer (i.e., in good times). As a result, the asset holdings ratio of the insured to the uninsured decreases (0.98 vs. 1.85 in the benchmark).

The same regression is performed in this economy, and the result is shown in column (C) of Table 8. In this case, PHI coverage also has a negative coefficient.

From the above two experiments, we have learned that if either social welfare or the uncertainty of EHI is removed, it is possible to observe a negative correlation between insurance coverage and savings. These results support the theory of precautionary savings. The same finding will be obtained if we remove both of the institutions (the result is listed in Appendix A5).

### 4.2.3 Counterfactual Experiment: Stochastic Health Insurance Coverage without Choice

One potential problem in Starr-McCluer’s and other similar studies is that health insurance status is not exogenous, and there may be a selection bias. Although Starr-McCluer has tried many methods for instrumentalizing insurance status, the same pattern has been found. The next experiment is intended to show that even if insurance coverage status is purely exogenous (i.e., there is no selection problem), a positive relationship between insurance coverage and savings will still be found empirically as long as the institutional distortion exists.

The experiment is constructed by turning off the insurance choices and assuming that insurance coverage is only determined by an EHI offer. Individuals face the same productivity and EHI offer uncertainties (the same $(z,e)$ transition probabilities) as in the benchmark, and all other parameters of the model remain unchanged. The results
are listed in the last row, case (D), of Table 7, and are quite similar to the benchmark case. The $K/Y$ ratio is slightly higher because the only option for those without an EHI offer who wish to hedge against the uncertainty of medical expenditures is to save. The labor supply also increases slightly for the purpose of saving.

The regression results are presented in the column of case (D) in Table 8, and are similar to those in the benchmark. On the one hand, the experiment confirms Starr-McCluer’s finding: the selection bias is unlikely to be the main reason for the puzzling insurance and savings pattern. On the other hand, it indicates that the empirical result is still biased because the regression model is unable to correct the distortion caused by the institutional factors.

Some additional experiments – a case of a more generous social welfare system and a case of removing both the uncertainty of insurance coverage and the social welfare – are also performed and presented in Appendix A5. A further robustness check with alternative utility settings is provided in Appendix A6, and shows that the main result still holds.

5 Concluding Remarks

Considering a standard model of precautionary saving, a puzzling positive correlation between private health insurance coverage and household asset holdings in the US has been reported by Starr-McCluer (1996). This study suggested that those findings can be explained by the existence of two institutions: a large social insurance (safety net) system and an employment-based health insurance system. To analyze this issue, I built a dynamic stochastic general equilibrium model that incorporates these two institutions with heterogeneous agents making decisions regarding saving, labor supply, and health insurance endogenously. I showed that the model can generate the same empirical finding as found in Starr-McCluer (1996). This result does not depend on the assumptions of heterogeneity of risk aversion or preferences.

These findings call into question the appropriateness of those empirical approaches that are directly based on the standard consumption-saving theory for testing the precautionary saving hypothesis. Applying the empirical approach in the model economy, the regression result is consistent with Starr-McCluer’s empirical finding, but the positive coefficient of PHI coverage does not imply the nonexistence of precautionary saving. In fact, households do have a motive to engage in precautionary saving in the model economy. The regression results must be interpreted carefully because the regression model captures the net saving effect of health insurance rather than the effect on precautionary savings exclusively. To appropriately test for the existence of precautionary saving or
to investigate the substitution effect of insurance on precautionary saving, it is necessary to control for the effects caused by these institutional factors. The counter-factual experiments have demonstrated that if either the social insurance or the EHI system is eliminated, the regression would generate a negative coefficient of PHI coverage that supports the precautionary saving hypothesis. The analysis in this study indicates that an economy with a low-level social assistance and without the feature of employment-based insurance coverage would be a better environment for conducting an empirical study regarding this issue. Nevertheless, in practice it is generally difficult to distinguish the effects on saving caused by the institutions from the effect of insurance on precautionary saving. Further research is required to resolve this difficulty.

References


**Appendix**

**A1. The joint \((z,e)\) transition matrix**

A joint 10 by 10 transition matrix of \(z\) and \(e\) \((\hat{\Pi}(z',e')(z,e))\) is constructed by summing up the weights of individuals who transit from one of the ten \((z,e)\) states in the first year to
a state in the second year \((z', e')\) in the MEPS data.

\[
\hat{\Pi}_{(z', e')|(z, e)} = \begin{bmatrix}
\hat{\Pi}_{(z', e'=1)|(z, e=1)} & \hat{\Pi}_{(z', e'=0)|(z, e=1)} \\
\hat{\Pi}_{(z', e'=1)|(z, e=0)} & \hat{\Pi}_{(z', e'=0)|(z, e=0)}
\end{bmatrix}
\]

The 2001–04 MEPS data show that on average 65.7% of non-elderly individuals (household heads) had EHI offers. An ideal transition matrix \(\Pi_{(z', e')|(z, e)}\) for the model should imply an EHI offer rate that is close to 65.7% in its stationary distribution. However, the stationary EHI offer rate implied by \(\hat{\Pi}_{(z', e')|(z, e)}\) is much lower at 47.4%. To ensure that the stationary distribution of the transition matrix can match the average EHI offer rate, some adjustments are needed. I assume there is some transitory bias from the simple construction of \(\hat{\Pi}_{(z', e')|(z, e)}\) that leads to a general and proportional under-estimation of these transition probabilities. Therefore, I impose a function \(\xi\) such that the true transition matrix \(\Pi_{(z', e')|(z, e)}\) can be constructed:

\[
\Pi_{(z', e')|(z, e)} = \begin{bmatrix}
(1 + \xi)\hat{\Pi}_{(z', e'=1)|(z, e=1)} & (1 - \xi)\hat{\Pi}_{(z', e'=0)|(z, e=1)} \\
(1 + \xi)\hat{\Pi}_{(z', e'=1)|(z, e=0)} & (1 - \xi)\hat{\Pi}_{(z', e'=0)|(z, e=0)}
\end{bmatrix}
\]

I calibrate \(\xi\) so that the transition matrix \(\Pi_{(z', e')|(z, e)}\) implies a stationary EHI offer rate matching the data average. The calibration result shows that \(\xi\) is 0.155 and

\[
\Pi_{(z', e')|(z, e)} = \begin{bmatrix}
0.377 & 0.243 & 0.045 & 0.003 & 0.000 & 0.297 & 0.032 & 0.003 & 0.000 & 0.000 \\
0.065 & 0.697 & 0.067 & 0.007 & 0.001 & 0.060 & 0.096 & 0.008 & 0.000 & 0.000 \\
0.031 & 0.061 & 0.794 & 0.037 & 0.004 & 0.017 & 0.005 & 0.051 & 0.002 & 0.000 \\
0.006 & 0.016 & 0.069 & 0.834 & 0.012 & 0.006 & 0.004 & 0.007 & 0.047 & 0.001 \\
0.049 & 0.002 & 0.027 & 0.106 & 0.768 & 0.004 & 0.000 & 0.006 & 0.006 & 0.034 \\
0.173 & 0.045 & 0.010 & 0.001 & 0.000 & 0.706 & 0.055 & 0.009 & 0.001 & 0.000 \\
0.052 & 0.270 & 0.045 & 0.007 & 0.000 & 0.155 & 0.432 & 0.033 & 0.008 & 0.000 \\
0.027 & 0.054 & 0.282 & 0.012 & 0.001 & 0.053 & 0.070 & 0.472 & 0.026 & 0.004 \\
0.003 & 0.011 & 0.035 & 0.245 & 0.010 & 0.019 & 0.052 & 0.077 & 0.544 & 0.004 \\
0.030 & 0.000 & 0.004 & 0.024 & 0.230 & 0.063 & 0.000 & 0.023 & 0.024 & 0.602
\end{bmatrix}
\]

**A2. Transition of medical expenditures**

The transition probabilities for the Markov chain of medical expenditures are calibrated based on the report in Jeske and Kitao (2009). The results of the calibration of medical expenditure transitions for the young and the old are reported in Table 9.
Table 9: Transition probabilities of medical expenditures

<table>
<thead>
<tr>
<th>The young ($X_i$)</th>
<th>Low</th>
<th>Fair</th>
<th>High</th>
<th>Very High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>0.784</td>
<td>0.199</td>
<td>0.014</td>
<td>0.003</td>
</tr>
<tr>
<td>Fair</td>
<td>0.337</td>
<td>0.591</td>
<td>0.062</td>
<td>0.009</td>
</tr>
<tr>
<td>High</td>
<td>0.173</td>
<td>0.562</td>
<td>0.200</td>
<td>0.065</td>
</tr>
<tr>
<td>Very High</td>
<td>0.105</td>
<td>0.376</td>
<td>0.286</td>
<td>0.233</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>The old ($X_o$)</th>
<th>Low</th>
<th>Fair</th>
<th>High</th>
<th>Very High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>0.762</td>
<td>0.217</td>
<td>0.019</td>
<td>0.003</td>
</tr>
<tr>
<td>Fair</td>
<td>0.368</td>
<td>0.551</td>
<td>0.062</td>
<td>0.018</td>
</tr>
<tr>
<td>High</td>
<td>0.218</td>
<td>0.591</td>
<td>0.137</td>
<td>0.054</td>
</tr>
<tr>
<td>Very High</td>
<td>0.118</td>
<td>0.608</td>
<td>0.264</td>
<td>0.010</td>
</tr>
</tbody>
</table>

Original source: MEPS.

A3. Health insurance coverage

MEPS records whether an individual actually held insurance at a current main job in variables ‘held31x’, ‘held42x’ and ‘held53x’ for three subperiods of a year. I assume that an individual was covered by EHI if he or she held an EHI plan at least for one subperiod in a year. From 2001 to 2004, the average EHI coverage in the working-age population is roughly 60% and the take-up ratio when EHI is offered is 91%.

MEPS also has variables recording the sources of private insurance. To determine an individual’s IHI coverage, three variables – ‘pngmmyy’ (covered by nongroup insurance in month $mm$ year $yy$), ‘prs$mm$’ (covered by self-employed insurance in month $mm$ year $yy$) and ‘pdk$mm$yy’ (covered by source-unknown private insurance in month $mm$ year $yy$) – are considered. If an individual was covered through any of the three insurance sources for at least 4 months (1/3 of a year), he or she is counted as a IHI holder in year $yy$. According to this definition, the average IHI coverage in the period 2001–2004 is 3%.

A4. Measure of permanent income in the regression

I follow the method used in Starr-McCluer to construct permanent income from cross-section data with some simplifications (e.g., the model does not have different cohorts,
and therefore the cohort effect variable is not included in the estimation). The function determining permanent income is

\[ \ln Y_{pi} = X_i' B + s_i \]

where \( X_i \) is a vector of individual characteristics for agent \( i \), \( B \) is the parameter vector and \( s_i \) is an individual-specific error component with a zero mean. Observed current income differs from permanent income due to transitory changes. The current income for individual \( i \) at time \( t \) is:

\[ \ln Y_{ci} = \ln Y_{pi} + u_{it} \]

where \( u_{it} \) is a transitory component to earnings, which has a zero mean and is assumed to be uncorrelated with \( s_i \). Combining the above two equations:

\[ \ln Y_{ci} = X_i' B + s_i + u_{it}. \]

The error term \((s_i + u_{it})\) has a zero mean and a variance equal to the sum of variances of its components. The estimator of permanent income that minimizes measurement error is a combination of \( Y_{ci} \) and \( X_i' B \), weighted by a correlation coefficient \( \pi \):

\[ Y_{pi}^* = \pi Y_{ci} + (1 - \pi) \exp(X_i' \hat{B}). \]

Starr-McCluer assumes permanent income is a function of age, family structure, gender, race, education, region, occupation and industry. In the model economy, I do not directly observe these variables. I assume that variation in the exogenous labor productivity in the model reflects the differences in individuals’ education, regions, occupations and industries, and use it as \( X_i \). I also follow Starr-McCluer to set \( \pi = 0.5 \) for household heads earning above $3000; for other heads, \( \pi \) is set at zero.

**A5. Additional experiments on institutional factors**

Two additional experiments are performed for a further investigation of the mechanism. The first is a case with a more generous social insurance system, \( \hat{\xi} = 0.25\bar{y} \). All other parameters are the same as in the benchmark. The results are presented in the second row (the case labeled ‘Add1’) in Table 10. The direct effect of the increase in social welfare is a reduction of uncertainties that discourages both saving and insurance purchasing. Therefore a decline in \( K/Y \) ratio is observed simply because of the decrease in precautionary savings. Individuals who have an EHI offer choose either to take it or turn it down without purchasing any insurance because an IHI plan gives the same benefit.
Table 10: Additional experiments

<table>
<thead>
<tr>
<th></th>
<th>K/Y ratio</th>
<th>Labor hours</th>
<th>PHI cov.</th>
<th>EHI cov.</th>
<th>PHI take-up (offered)</th>
<th>Assets (ratio to $a_{un}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bench</td>
<td>3.0</td>
<td>0.33</td>
<td>64%</td>
<td>61%</td>
<td>3%</td>
<td>1.85 1.87 1.51</td>
</tr>
<tr>
<td>Add1</td>
<td>2.8</td>
<td>0.32</td>
<td>64%</td>
<td>59%</td>
<td>5%</td>
<td>1.85 1.94 0.79</td>
</tr>
<tr>
<td>Add2</td>
<td>3.3</td>
<td>0.41</td>
<td>61%</td>
<td>61%</td>
<td>–</td>
<td>0.94 0.94 –</td>
</tr>
</tbody>
</table>

Notes: (Add1) better social welfare ($c = .25\bar{y}$); (Add2) removing the uncertainty of insurance coverage (fixed insurance status) and the social welfare ($c = .01\bar{y}$). PHI includes EHI and IHI. $a_{un}$: average asset holdings of uninsured individuals.

Table 11: Regression results: additional experiments

<table>
<thead>
<tr>
<th>Explanatory variable</th>
<th>Economies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bench</td>
</tr>
<tr>
<td>Permanent income</td>
<td>1.53</td>
</tr>
<tr>
<td>Health problems</td>
<td>-0.59</td>
</tr>
<tr>
<td>PHI coverage</td>
<td>3.66</td>
</tr>
</tbody>
</table>

Note: All coefficients are significant at the 5% level.

at a greater cost than the highly subsidized EHI (the IHI coverage of those with an EHI offer is zero). Clearly, a decline in the EHI take-up ratio among those who have a EHI offer is observed, especially for those with lower wealth who are more likely to qualify for social welfare benefits and have a lower incentive to keep EHI. For those without an EHI offer, an increase in the IHI take-up ratio is observed (14.7% vs. 9.5% in the benchmark) that leads to higher IHI coverage (5%). In general, they reduce savings, but there is an adjustment on the portfolio between assets and health insurance because assets become less attractive in terms of qualifying social welfare. A substitution effect is observed in this case. However, the general positive pattern of insurance coverage and savings still holds as in the benchmark and the regression delivers a similar result (see Table 11 under the label Add1.).

The second is a case of removing both the uncertainty of EHI and the original social welfare. Health insurance coverage is predetermined as in Section 4.2.2. The difference from the case in Section 4.2.2 is that the social insurance system is also removed and replaced by a minimum $c = .01\bar{y}$ as in Section 4.2.1. The result is presented in the third row, case labeled ‘Add2’, in Table 10. The regression result is shown in Table 11 under the label Add2. As expected, we observe an opposite insurance-savings correlation.
compared with the benchmark when both of the two institutional factors are removed.

A6. Robustness check: Alternative utility and labor elasticity

The labor supply is endogenous in the model, and so individuals are able to adjust their labor/leisure according to the shocks they receive. This option enhances their ability to fight against uncertainties and smooth their consumption/utility. The period utility function specified in the above analysis is consistent with balanced growth and widely used in the macro literature. Here alternative utility settings are adopted for a robustness check.

Inelastic labor supply

I first examine the case with an inelastic labor supply. The period utility function is simply

\[ u(c) = \frac{c^{1-\mu}}{1-\mu} \]

where \( \mu \) is selected to be 3 (i.e., the case \( \phi = 1 \) in the benchmark utility function). All calibration targets are the same as in the benchmark. I find that a higher markup parameter \( \psi \) (23\%) is needed to match the IHI coverage (see the third row, the case labeled ‘IneL’, in Table 12 ), compared with 6.5\% in the benchmark model. A higher EHI take-up ratio, 95\%, is also found (vs. 93\% in the benchmark).

I perform a counterfactual experiment using the utility function with inelastic labor, in which \( \psi \) is set at 6.5\% as in the benchmark model. The result shows that IHI coverage increases to 18\% from the calibration target 3\%.

In addition, the gap between the assets held by the insured and by the uninsured is narrowed, but the main pattern of savings and insurance coverage still holds. The regression result (the column under IneL in Table 13) is also similar to that in the benchmark model.

The comparison indicates that the demand for insurance will be higher when the ability of adjusting labor hours/leisure is low.

Separable Utility

An alternative utility function is considered that is widely used in micro literature on consumption and labor supply:

\[ u(c, 1-n) = \frac{c^{1-\mu_1}}{1-\mu_1} + \eta \frac{(1-n)^{1-\mu_2}}{1-\mu_2} . \]
Table 12: Alternative utility

<table>
<thead>
<tr>
<th>Model</th>
<th>ψ</th>
<th>PHI cov.</th>
<th>EHI cov.</th>
<th>IHI cov.</th>
<th>EHI take-up (offered)</th>
<th>Assets (ratio to $a_{un}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bench</td>
<td>6.5%</td>
<td>64%</td>
<td>61%</td>
<td>3%</td>
<td>93%</td>
<td>1.85</td>
</tr>
<tr>
<td>SepU</td>
<td>13.0%</td>
<td>69%</td>
<td>66%</td>
<td>3%</td>
<td>100%</td>
<td>1.43</td>
</tr>
<tr>
<td>IneL</td>
<td>23.0%</td>
<td>65%</td>
<td>62%</td>
<td>3%</td>
<td>95%</td>
<td>1.60</td>
</tr>
</tbody>
</table>

Experiment: $ψ = 6.5\%$ as in the benchmark

| SepU    | 6.5% | 84% | 66% | 18% | 100% | 1.25 | 1.36 | 0.86 |
| IneL    | 6.5% | 80% | 62% | 18% | 95% | 1.62 | 1.76 | 1.14 |

Notes: ‘Bench’ benchmark; ‘SepU’ the case of separable utility with lower labor elasticity; ‘IneL’ the case of inelastic labor supply. $ψ$ is the parameter of private insurance markup.

Table 13: Regression results: alternative utility

<table>
<thead>
<tr>
<th>Explanatory variable</th>
<th>Alternative utility settings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bench</td>
</tr>
<tr>
<td>Permanent income</td>
<td>1.53</td>
</tr>
<tr>
<td>Health problems</td>
<td>-0.59</td>
</tr>
<tr>
<td>PHI coverage</td>
<td><strong>3.66</strong></td>
</tr>
</tbody>
</table>

Notes: ‘Bench’ benchmark; ‘SepU’ the case of separable utility with lower labor elasticity; ‘IneL’ the case of inelastic labor supply. All coefficients are significant at the 5% level.

$\mu_1$ is selected to be 3 as the utility parameter $\mu$ in the benchmark. I follow Conesa et al. (2009) and set $\mu_2 = 3$, which implies a smaller average Frisch labor supply elasticity than in the benchmark.

The time discount factor $\beta$ and the utility parameter $\eta$ are selected so that the resulting capital-output ratio and average labor hours can match those in the benchmark economy. The Frisch labor supply elasticity according to the new preference specification can be calculated as $(1 - n)/(\mu_2 n)$. All other calibration targets are the same as in the benchmark. I find that a higher private insurance markup parameter $ψ$, 13%, is needed to match the IHI coverage. The EHI take-up ratio of those receiving EHI offers

---

is also higher at 100% (vs. 93% in the benchmark). The result is presented in the second row, the case labeled ‘SepU’, in Table 12. I also perform a counterfactual experiment with the separable utility function, in which $\psi$ is set at 6.5% as in the benchmark model. A higher IHI coverage, 18%, is found. It also indicates that a decreased ability to adjust labor/leisure increases the demand of insurance.

Although a different utility function is adopted and the gap between the assets held by the insured and the uninsured is narrowed, the general pattern of savings and insurance coverage still holds. The regression also shows a similar result (the column under SepU in Table 13) to the benchmark model.

As a conclusion of the robustness check and the investigation of labor elasticity, both of the above exercises do not qualitatively change the result obtained in the benchmark, and indicate that a lower flexibility of labor/leisure adjustment (that helps consumption/utility smoothing) might increase the demand of insurance. The question of which utility setting is better would be an interesting research topic but is beyond the scope of this paper. Regardless, the main result in the benchmark model still holds with either utility setting.