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THE PROVISION OF PUBLIC UNIVERSAL HEALTH INSURANCE: IMPACTS ON PRIVATE INSURANCE, ASSET HOLDINGS, AND WELFARE

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This paper aims to investigate impacts of public provision of universal health insurance (UHI) in an environment with household heterogeneity and financial market incompleteness. Various UHI polices with both distortionary and nondistortionary financing methods are compared to address the trade-off between risk reduction and tax distortion, as well as the corresponding welfare implications. We use a dynamic equilibrium model with endogenous insurance choice and labor supply decisions to perform quantitative analysis. The results suggest that the UHI expenditure coverage rate is too high in most OECD countries when the distortion effect is considered. We find a clear crowding-out effect on asset holdings. Implications for private health insurance (PHI) purchases when UHI is introduced depend on the pricing and the design of coverage. We find that the rich are sensitive to the price of PHI, and would prefer a supplemental plan when UHI is introduced.

Keywords: Health Insurance, Public Policy, Taxes

1. INTRODUCTION

Most OECD countries offer universal health insurance (UHI). A number of middle-income countries have also recently achieved universal health care (e.g., Korea, Taiwan, Singapore), and many others are moving in that direction (e.g., China, Mexico, Turkey). In fact, the World Health Organization (WHO) encourages countries to pursue universal coverage as a means of improving and equalizing health care (the World Health Report for 2008). UHI is desired for a variety of

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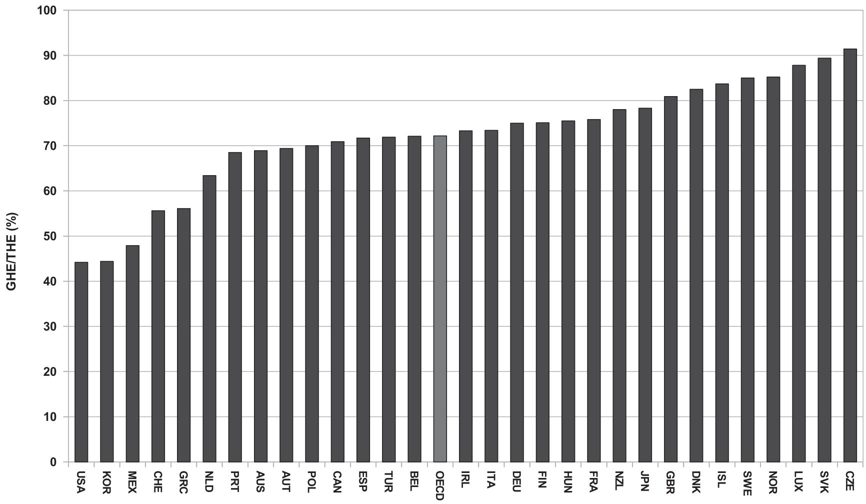

FIGURE 1. GHE as percentage of total health expenditure. *Source*: Colombo and Tapay (2004).

reasons that include preventing adverse selection problems existing in private insurance market. Its pooling contract makes health insurance affordable for those with chronically poor health. Moreover, UHI reduces the need for precautionary savings, and might also reduce the administrative cost of insurance because of less need for screening and monitoring.

However, the current literature provides very limited analyses on impacts of UHI provision with an aggregate economy framework. This paper aims to shed light on this issue. In this paper, we focus on a specific form of UHI — a government-sponsored mandatory universal health insurance program, which is adopted in many OECD countries and middle-income countries, which recently achieved universal coverage. This type of UHI is also widely considered by countries that are moving in the universal coverage direction.

Governments commonly play an important role in UHI provision because of the adverse selection problem in private insurance markets. We observe that in OECD countries with UHI available, government health care expenditures are usually much higher than private health care expenditures (see Figure 1). The provision of UHI prevents the adverse selection problem and is expected to improve the social fairness of health care. In addition to equalizing health insurance coverage, the introduction of UHI will bring impacts on individuals and the economy in many aspects. First, universal coverage generally reduces the level of uncertainty (i.e., improves risk sharing) and therefore precautionary savings. In addition, mandatory public UHI will crowd out private health insurance (PHI) and asset holdings, which will change household's portfolio choices, wealth distribution, and aggregate capital stock. Moreover, to finance UHI, the government has to increase

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its revenue. A payroll tax (including earnings-dependent insurance premiums) is widely adopted for financing the UHI. Although this is viewed as more "fair" because high-earnings individuals pay more for the same insurance plan, it has a distortionary effect on labor/leisure decisions. There is obviously a trade-off between risk reduction and tax distortion. A nondistortionary financing method will be examined to disentangle the distortion caused by payroll-tax financing.

We particularly focus on the effects of the increased tax burden/distortion, risk reduction, and the interaction with PHI and asset holdings. These effects will change individuals' decisions on savings, hours worked, and portfolio choice between insurance and assets, and therefore change aggregate labor supply, capital stock, wealth distribution, and welfare. Because of the complexity of interactions and impacts, welfare changes at both the individual level and the aggregate level are not trivial to predict.

To better understand the impacts of the public UHI provision, we develop a dynamic stochastic equilibrium model with household heterogeneity, financial market incompleteness, and endogenous demand for PHI. In addition to PHI, households can accumulate assets to self-insure against income and medical shocks in a precautionary motive. When a mandatory tax-financed UHI program is introduced that partially covers the medical expenditure shocks for every household, PHI, which now provides additional coverage for the rest of the medical shocks, becomes complementary to UHI. The price of PHI therefore will decrease in response to the introduction of UHI and it will become more affordable. On the other hand, the medical risk has been reduced by the UHI coverage and so the demand for PHI will decrease, as well as the necessity of precautionary savings. After the UHI is introduced, the change in PHI take-up ratio then depends on which force dominates.

We perform a quantitative investigation on impacts of the UHI provision. A benchmark economy without UHI and economies with the UHI provision are compared. Clear crowding-out effects are observed both on assets and on PHI purchases. A redistribution effect on welfare, rather than on wealth, is found—the old gain more than the young, and the low-wealth gain more than the high-wealth.

Compared with lump-sum tax (nondistortionary) financing, we also identify the distortion caused by the payroll tax financing of the UHI, which reduces labor supply and further crowds out PHI purchasing and asset holdings. The loss from payroll tax distortion creates a welfare gap between the UHI provisions with a payroll tax financing method and with a lump-sum tax financing method.

A UHI policy with a higher expenditure coverage rate provides better risk sharing, but also needs a higher tax rate to finance it. Hence there is a trade-off between risk sharing and tax distortion. The result shows an inverse U-shaped welfare pattern with increased coverage rates. We find that when the UHI expenditure coverage rate is greater than 50%, the additional distortion loss outweighs the additional welfare gain in various scenarios. It suggests that the rates in most OECD countries might be too high (the average is about 70%) when the tax distortion is taken into account.

The demand for PHI when UHI is introduced is also discussed. We find that when UHI provides primary coverage and PHI becomes complementary, covering a proportion of out-of-pocket medical expenditures, wealth-rich individuals can easily use their assets to substitute for complementary PHI, and therefore are more sensitive to its price change. On the other hand, individuals with low wealth do not have this option and are less sensitive to the price change. We find that a supplemental PHI plan, which covers items not covered by UHI, would attract the rich more. We illustrate this by designing a catastrophic PHI that provides full coverage on the highest medical shock. We also find that if the proportion of markup of PHI is maintained at the same level after UHI is introduced and no new type of PHI is offered, insurance companies will lose customers. Particularly, richer individuals can more easily have options to replace the PHI.

This project is in the line of the literature of investigations of the effects of public insurance provision in incomplete market environments.[1] In the existing macro literature, it is widely agreed that medical expenditure shocks are important for understanding a household's expenditure-saving decisions. However, the health insurance decision is usually absent from the model. A recent paper documented by Jeske and Kitao (2009), which uses a similar model to study welfare effects of U.S. tax policy on health insurance, is one that allows households to purchase health insurance endogenously. This paper also allows endogenous insurance purchasing, but we focus on the interaction between public mandatory UHI and decisions on purchasing PHI. In addition, the distortionary impact that tax policy has on consumption–leisure decisions is not discussed because labor supply is assumed inelastic in Jeske and Kitao's analysis. We allow endogenous choice of labor supply, and find it is important when studying social welfare.[2] Another related paper is Attanasio et al. (2010). They use a life-cycle model to study the financing of Medicare, a public UHI for elders in the United States. They also allow endogenous labor decisions and take into account demographic changes. However, they do not discuss the endogenous demand for private health insurance, which is not their focus.

The rest of the paper is organized as follows. In the next section, we present some facts on health insurance systems in OECD countries. Section 3 presents model economies. Section 4 discusses the choices of parameter values and describes the calibration. Section 5 provides quantitative analyses and results with robustness tests. Section 6 concludes.

2. SOME FACTS FROM THE OECD

2.1. Size of Public Health System Varies across Countries

Colombo and Tapay (2004) investigated health insurance systems in OECD countries. They provide data on public (government) health expenditure (GHE) and the expenditure that is covered by private health insurance. Only four among the OECD countries, the United States (USA), the Netherlands (NLD), Mexico

(MEX), and Turkey (TUR), do not provide UHI, although forms and benefits of UHI vary across those countries. Figure 1 shows the GHE as a percentage of total health expenditure across OECD countries, which can be used to approximate the size of the public health insurance system of each country (or the average coverage rate of public health insurance). High heterogeneity (roughly from 40% to 90%) is observed. The United States, which does not provide UHI, has the smallest public health system among OECD countries.

2.2. Size of Public Health System vs. Private Health Insurance

Figure 2 shows the relationship between the private health insurance expenditures and public health expenditures as shares of total health expenditure across OECD countries. It also shows high heterogeneity of private health insurance expenditures. The PHI expenditure share varies from 35.1% (United States) to a negligible share. The GHE share is negatively related to the PHI expenditure share. The correlation is −.65.

Figure 2 displays the relationship between the percentage of the population covered by PHI (i.e., the PHI take-up ratio) and the GHE share across OECD countries. The PHI take-up ratio ranges from 71% (United States) to a negligible share and is negatively correlated with the GHE share (−.36). These facts, observed from the OECD data, suggest that the more public health insurance covers, the less private health insurance covers health expenditure and the less people purchase private health insurance. It indicates a crowding-out effect of the public health system on private health insurance.

3. THE MODEL

We undertake a theoretical approach to understanding the interaction among UHI provision, PHI purchases, asset holdings, and the implications for welfare. A theoretical model economy is developed to characterize the main factors that affect portfolio choice between assets and insurance.

In the model economy, there is no aggregate uncertainty, but households face idiosyncratic labor productivity shocks and medical expenditure shocks. Financial markets in which households may trade full contingent claims against these risks are assumed to be unavailable. Instead, first, households can trade a non–state contingent asset at a price of one unit of consumption good. This non–state contingent asset enables households to partially self-insure by accumulating precautionary asset holdings. Second, there exists a health insurance market where households can buy an insurance plan to hedge against the next periods medical expenditure shock.

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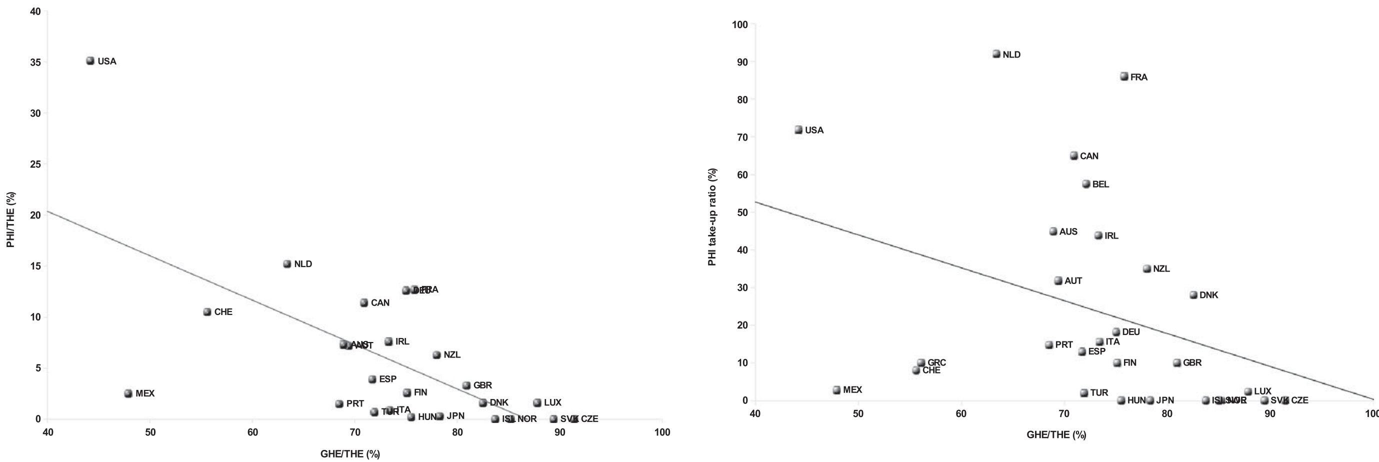

FIGURE 2. GHE vs. PHI Expenditure and GHE vs. PHI take-up ratio. *Source*: Colombo and Tapay (2004).

3.1. Demographics

The economy is populated by a continuum of finitely lived households (measure one) and they maximize expected discounted lifetime utility from consumption and leisure. The population consists of two generations—the young and the old. Young agents supply labor and earn wage income and old agents are retired from market work and receive social security benefits. Young agents become retired with probability ρ_o every period and the old die and leave the economy with probability ρ_d every period. On average, the young work for $(1/\rho_o)$ years, and the old live for $(1/\delta_d)$ years before they die. In each period, the economy has newborn young households, which replace the old households that die, so that the measure of total population stays constant. A similar setting, stochastic aging and death, is also used in Jeske and Kitao (2009) to capture the features of retirement and death, which clearly have effects on agents' saving and insurance purchasing decisions, in an Aiyagari–Bewley type model. The demographic setting with the probabilities described implies that in every period there is a fraction $\frac{\rho_o}{\rho_o+\rho_d}$ of old people and a fraction $\frac{\rho_d}{\rho_o+\rho_d}$ of young people.

3.2. Labor and Medical Expenditure Shocks

Young households effective labor supply depends on the hours worked and idiosyncratic labor productivity shock z, which is stochastic. In each period t, an idiosyncratic labor productivity shock takes one of $l < \infty$ values in a finite set $Z = \{z_1, z_2, ..., z_l\}$. Each household's productivity shock evolves independently according to a first-order Markov process with transition probability matrix π_z, which is $l \times l$, and an invariant distribution $\bar{\pi}_z$.

Both young and old households faces medical expenditure shocks x, which are also stochastic. In each period t, each household's medical expenditure shock takes one of $m < \infty$ values in a finite set $X_i = \{x_{1,i}, x_{2,i}, ..., x_{m,i}\}$ for $i \in \{o, y\}$, representing old and young, respectively. Each household's medical expenditure shock also evolves independently according to a first-order Markov process with transition probability matrix $\pi_{x,i}$, which is $m_i \times m_i$ for $i \in \{o, y\}$, and an invariant distribution $\bar{\pi}_{x,i}$ for $i \in \{o, y\}$.

3.3. Asset and Health Insurance Market Structures

Asset market. There is a non–state contingent claim, which is an asset that households can purchase at one unit of consumption good and pays off $(1+r) \geq 1$ units of consumption good next period. By trading this non–state contingent claim, households can partially insure themselves against any combination of idiosyncratic productivity shocks and medical expenditure shocks by accumulating precautionary asset holdings. One assumption that we made to present market incompleteness is that households are subject to a borrowing constraint. This borrowing limit on households' asset holdings especially affects the asset-holding decision of low-wealth households, because they cannot smooth their consumption over time when they are hit by falls in their disposable incomes.

Universal health insurance program. When UHI is introduced, it mandatorily covers a constant fraction ω of a household's medical expenditure x. Households pay $(1-\omega)\,x$ units of the consumption good when the medical expenditure x is realized under UHI coverage. This universal health insurance (UHI) program is financed by tax revenues. We use a higher ω to represent an economy with better UHI benefits in our numerical exercise.

Private health insurance market. In each period, households can still purchase a private health insurance contract that covers an additional fraction $\omega_p(x)$ of medical cost x even with the UHI provided. Hence with the health insurance contract, the net health expenditure becomes $\left(1-\omega-\omega_p(x)\right)x$, whereas it will cost the entire $(1-\omega)\,x$ without private insurance. Households make a decision on whether to purchase a private insurance contract that will cover the fraction of the next period's medical expenditures.

If a household decides to buy private health insurance, a premium $q\,(x)$ has to be paid each period. The premium $q\,(x)$ is assumed to depend on the current state of medical expenditure x. This implies that we assume that there is price discrimination in the health insurance market.

Health insurance companies are risk-neutral and competitive. They can monitor each household's state of health expenditure without costs, and each household's state of health expenditure is public information. They charge premium $q\,(x)$ such that the total amount covered by a contract is exactly financed by the total amount of the premiums paid by the households. An insurance company can discriminate premiums for different contracts depending on the current state of an individual's medical expenditure. We assume that there is no cross subsidy across contracts. The premium for the insurance contract that is offered to the household whose current medical expenditure state is x satisfies:

$$q\,(x) = (1+\psi)\,E[\omega_p(x')\cdot x'|x] = (1+\psi)\,\pi_{x,i}(x'|x)\omega_p(x')\cdot x', \qquad \textbf{(1)}$$

where $\omega_p(x) \in [0,1]$ denotes the fraction of total medical expenditure (x) that is covered by the PHI program and ψ denotes the proportional markup for the insurance contract.

We set the effective coverage of PHI $\bar{\omega}_p(x)$ to be constant given the medical expenditure state x, which means that PHI covers $\bar{\omega}_p(x)$ of the remaining medical expenditure beyond the UHI coverage. Hence the PHI coverage of total medical expenditure $\omega_p(x)$ is linearly decreasing with the UHI coverage: $\omega_p(x) = \bar{\omega}_p(x)(1-\omega)$ Given this assumption, the premium of PHI is also decreasing with the UHI coverage from equation (1), because $\omega_p(x)$ decreases with UHI coverage.

3.4. Government

The government's revenue consists of revenues from different tax instruments, labor income tax τ_n, capital income tax τ_k, consumption tax τ_c, lump-sum tax TAX, social security tax τ_{ss}, and newly issued government debt D'. The social security tax τ_{ss} is imposed on the young households' labor income. Bequests b are collected by the government as a revenue that reduces the TAX.[3]

The government runs three social programs: a social security program, a social insurance (safety net) program, and a universal health insurance program. The social security program provides the old (retired) households with a benefit ss and it is financed by the social security tax imposed on the labor income of the young households.

The government provides social insurance that guarantees a minimum level of consumption $\underline{c}$ for every households by supplementing its income in case the household's disposable income plus assets (net after medical expenditure) falls below $\underline{c}$. We consider a simple transfer rule proposed by Hubbard et al. (1995). The transfer T will be made if the household's disposable income plus assets (net after medical expenditure) is smaller than a minimum level of consumption. The transfer amount will be exactly equal to the difference.

The government also provides a universal health insurance program that covers a constant fraction ω of the total medical expenditure of all households. There is other government expenditure G, which is constant. The social insurance (safety net) program, the universal health insurance program, and other government expenditures are financed by the revenues from the consumption tax and income tax.

Having described the revenues and expenditures of government, we now can give the set of government budget constraints:

1. The social security benefit to the old is financed by the social security tax τ_{ss} imposed on labor incomes of the young,

$$\int (ss) d\Phi = \int \tau_{ss}(wzn) d\Phi, \tag{2}$$

where Φ is the distribution of households over the state space.

2. Social insurance, universal health insurance, and other government expenditures are financed by the revenue from labor income tax (τ_n), capital income tax (τ_k), consumption tax (τ_c), lump-sum tax (Tax), and new government debt (D'),

$$G + \int [T + \omega x] d\Phi + (1+r)D = \int [\tau_n(wzn) + \tau_k(ra) + \tau_c c + \text{Tax} + (1+r)b] d\Phi + D', \tag{3}$$

where T is a transfer to the individual made for social insurance, x is individual medical expenditure, a is an individual's asset holding, and b is the bequest left by old agents when they die.

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3.5. Production Technology

On the production side, we assume that there are 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, which we assume to be constant. Capital depreciates at a rate of δ every period. θ denotes the capital income share.

3.6. Household

Preference. We adopt a standard utility function $u(c, n)$ that is consistent with a balanced growth path and widely used in the growth literature,

$$u(c, n) = \frac{\left[c^{\phi}(1-n)^{1-\phi}\right]^{1-\mu}}{1-\mu}, \tag{4}$$

where μ is the relative risk aversion coefficient.[4]

Young household's problem. The state of an agent is summarized by a vector $s = (a, z, x, i_{\text{HI}})$, where a denotes asset holdings brought into the period, z the idiosyncratic shock to labor productivity, and x the idiosyncratic health expenditure shock that has to be paid. The indicator function i_{HI} takes a value of 1 if the agent purchased private health insurance in previous period and 0 otherwise:

$$V(s) = \max_{c,n,a',i'_{\text{HI}}} \left\{u(c, n) + \beta(1-\rho_o) E\left[V\left(s'\right)\right] + \beta\rho_o E\left[V_o\left(s'\right)\right]\right\},$$

subject to

$$(1+\tau_c)c + a' + q(x)\, i'_{HI} = \text{Wel}_y + T,$$

$$\text{Wel}_y \equiv (1-\tau_{ss}-\tau_n)\, wzn + [1 + (1-\tau_k)\, r]\, a - \left[1-\omega - i_{HI}\omega_p(x)\right] x - \text{Tax},$$

$$T = \max\{0,\ (1+\tau_c)\underline{c} - \text{Wel}_y\},$$

$$i'_{\text{HI}} \in \{0, 1\};\quad a' \geq 0;\quad 1 > n \geq 0,$$

where V_o is the value when the agent becomes old, and T is the transfer made by the means-tested social insurance system.

Old household. The retired, do not supply labor, and they receive social security payment ss as their main income source. Their labor productivity z is fixed at 0. Therefore they only face medical shocks without income shocks. They can also purchase a PHI plan to insure against the medical shocks in addition to the UHI coverage.

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An old agent's problem is

$$V_o(s) = \max_{c,a',i'_{HI}} \left\{ u(c,0) + \beta(1-\rho_d) E\left[V_o(s')\right] \right\}$$

subject to

$$(1+\tau_c)c + a' + q(x)\, i'_{HI} = \text{Wel}_o + T;$$

$$\text{Wel}_o \equiv ss + [1+(1-\tau_k)r]\,a - \left[1 - \omega - i_{HI}\cdot\omega_p(x)\right]x - \text{Tax};$$

$$T = \max\{0,\ (1+\tau_c)\underline{c} - \text{Wel}_o\};$$

$$i'_{\text{HI}} \in \{0,1\};\quad a' \geq 0.$$

Recursive competitive equilibrium. A stationary recursive competitive equilibrium consists of household decision rules of asset holding a', labor supply n, PHI purchase i'_{HI} and consumption c, a set of firm decision rules for capital rented K and effective labor employed L, a price system of w and r, a government policy of tax rates τ_n, τ_k, τ_c, and TAX, a government debt D, a policy of UHI coverage ω, a minimum consumption floor $\underline{c}$, and a distribution of households over the state variables $\Phi(s)$, such that (a) given the price system, the decision rules of K and L solve the firm's problem; (b) given the price system, the insurance premium, and the policy of tax rates, the decision rules of (a', n, c) solve the household's problem; (c) government policies $(\tau_k, \tau_n, \tau_c, \text{TAX}, \underline{c})$ satisfy the government's budget constraints; (d) $\Phi(s)$ is stationary; (e) all markets clear: $L = \int (zn)d\Phi(s)$ and $K + D = \int (a+b)d\Phi(s)$; and (f) the resource feasibility condition is satisfied.

4. CALIBRATION

Although we do not focus on a specific country, we calibrate the benchmark model economy to the United States. The main reason is that the benchmark is an economy without UHI, in which PHI is available, and the United States satisfies this requirement. More importantly, among the few OECD countries without UHI, the United States has good health expenditure and private insurance–related survey data that largely help our calibration.

4.1. Utility and Production Functions

The model period is set to be one year. The risk aversion parameter μ is set at 2. The utility discount factor (β) is chosen so that capital–output ratio is equal to 3. The leisure utility parameter ϕ is chosen so that aggregate labor hours are equal to 0.33.

In the production function, the capital income share (θ) is set at 0.33, and the depreciation rate of capital (δ) is set at 0.08. The scaling production parameter A is calibrated to normalize the average wage income in the benchmark unity.

4.2. Labor Productivity and Medical Expenditure Shocks

In the model, the labor efficiency shock (z_t) process is used to capture the income fluctuations. We employ a first-order autoregressive AR(1) process to approximate the pattern of logarithm of labor efficiency shocks (or equivalently, income shocks).[5] The process is set as

$$\log(z_{t+1}) = \rho_z \log(z_t) + \epsilon_{zt}, \tag{7}$$

where ρ_z is the serial correlation coefficient on labor productivity shock and ϵ_{zt} is white noise. We adopt the estimation provided by Hubbard et al. (1995). Because their estimation of income process, which is based on micro data, includes unemployment insurance benefits, it fits this model better than other estimaties based on aggregate data. They estimate the income-shock processes for three educational categories separately. Here the ρ_z is chosen to be 0.955 and the variance of ϵ_{zt} is set at 0.025, as in their middle-education group. We then apply the procedure described in Tauchen (1986) to approximate this AR(1) process using a three-state Markov chain, with a maximum and minimum equal to plus and minus 2 standard deviations of the unconditional distribution.

To characterize medical expenditure shocks, we directly use a Markov process instead of an AR(1) process because of the skewness of medical expenditure. We define four medical expenditure states as "low," " fair," "high," and "very high," which represent medical expenditure in the bottom 60%, from 60 to 95%, from 95 to 99%, and in the top 1%, respectively. Jeske and Kitao (2009) use a similar setting and estimate the process of medical expenditure based on the Medical Expenditure Panel Survey (MEPS). Based on the report from Jeske and Kitao (2009), we are able to calculate the mean medical expenditure of each group in the United States. working-age and retired population in 2003. These expenditures were 0.9%, 10.8%, 50.0%, and 159.4% as of the average income in 2003 for the working-age population, and were 4.9%, 28.5%, 103.6%, and 226.5% for the retired population. Therefore, we set the four-state medical expenditure shocks, X_y and X_o for the young and the old respectively, as the stated percentages of average labor income in the model (see Table 1).

The MEPS provides two-year panels since 1996 that allow estimation of transitions of medical expenditure states. Monheit (2003) uses the data from the 1996/1997 MEPS to study the persistence of medical expenditure. Jeske and Kitao (2009) also use the MEPS data to determine the transition probabilities of medical expenditure states. Our transition probabilities for the Markov chain of medical expenditures are calibrated based on the study of Jeske and Kitao (2009). The results are reported in Table 2.

4.3. Health Insurance

Private health insurance. Based on MEPS, the private health insurance provides various expenditure coverage rates depending on age and amount of medical

TABLE 1. States of medical expenditure

State	Expenditure range	The young (X_y) Average ($ in 2003)	The young (X_y) Ratio to avg. income (2003)	The old (X_o) Average ($ in 2003)	The old (X_o) Ratio to avg. income (2003)
Low	Bottom 60%	310	0.9%	1,630	4.9%
Fair	60 – 95%	3,597	10.8%	9,474	28.5%
High	95 – 99%	16,629	50.0%	34,455	103.6%
Very high	Top 1%	53,013	159.4%	75,329	226.5%

Original source: MEPS. Calculation based on Jeske and Kitao (2009).

expenditure. We use the report in Jeske and Kitao (2009) to set the effective coverage of PHI $\bar{\omega}_p(x)$ as (0.528 0.702 0.765 0.845) for the young and (0.315 0.511 0.637 0.768) for the old with the four medical expenditure states.

The PHI serves as the primary insurance in the benchmark economy, in which the UHI is not available. The markup ψ of PHI is chosen so that in the benchmark economy 70% of households purchase PHI, which is set to be consistent with the PHI market for the working-age population in the United States. Although we do not match the PHI take-up ratio by income group, the simulation in the benchmark shows that the PHI take-up ratio in the top 50% income group is 80% and the ratio in the bottom 50% income group is 60%, which is consistent with the phenomenon observed in the United States that PHI take-up ratio is increasing in income.

Universal health insurance. Various UHI policies are considered in our analysis to reflect the heterogeneity of UHI programs in the OECD countries. We use various expenditure coverage rates of UHI ω, from 30% to 90%, for our policy experiments. In these cases the PHI becomes supplementary and covers $\bar{\omega}_p(x)$ of the out-of-pocket expenditure $(1-\omega)x$ instead of total expenditure x.

TABLE 2. Transition probabilities of X

	The young (X_y)				The old (X_o)			
	Low	Fair	High	Very high	Low	Fair	High	Very high
Low	0.784	0.199	0.014	0.003	0.762	0.217	0.019	0.003
Fair	0.337	0.591	0.062	0.009	0.368	0.551	0.062	0.018
High	0.173	0.562	0.200	0.065	0.218	0.591	0.137	0.054
Very high	0.105	0.376	0.286	0.233	0.118	0.608	0.264	0.010

Original source: MEPS. Calculation based on Jeske and Kitao (2009).

TABLE 3. Summary of Parameters

Parameter	Notation	Value
Risk aversion	μ	2.00
Depreciation rate	δ	0.08
Capital income share	θ	0.33
Prob. of being retired	ρ_o	1/45
Prob. of death	ρ_d	0.0889
Fraction of the young	$\frac{\rho_d}{\rho_o+\rho_d}$	0.8
Social security benefit	ss	45% of average labor income
Min. consumption level	$\underline{c}$	10% of average labor income
Consumption tax rate	τ_c	0.05
Capital tax rate	τ_k	0.45
Labor tax rate	τ_n	0.35
Debt/GDP ratio		0.40

4.4. Social Security, Safety Net, and Government Taxation

The social security payment is set as 45% of the average labor income of the young adults. The minimum consumption floor provided by the safety net is set to 10% of average earning, as in Attanasio et al. (2010). The consumption tax rate is set at 5%, the capital income tax is 45%, and the labor income tax is 35% (including social security tax). Government debt-to-output ratio is 40%. These parameters are selected to match the features in the United States and also used in the literature.

5. QUANTITATIVE ANALYSIS

The benchmark is an economy in which UHI is not available. PHI serves as primary health insurance, and households make decisions on purchasing PHI, supplying labor, and holding assets. Households that decide not to purchase PHI becomes uninsured. Table 3 summarizes the parameter values in the benchmark economy.

We compare the benchmark economy and economies where the environments are the same as the benchmark except that a public UHI program is implemented. We assume that when UHI is introduced, PHI becomes a complementary insurance that partially covers the rest of medical expenditure beyond UHI coverage and that the markup of PHI does not change. Alternative PHI assumptions, when UHI is introduced, will also be discussed.

When the government provides UHI, it also needs to decide the expenditure coverage rate ω of the UHI and the financing method. If we use the fraction of public health expenditure in total health expenditure to approximate the ω, as we observe in Figure 1, it ranges between 40% and 90% among those OECD countries offering UHI. Most of those countries, which provide UHI, finance the UHI by payroll taxes and/or general government revenues. The payroll tax financing

TABLE 4. Aggregate features: benchmark vs. UHI ($\omega = 0.5$)

	ω	L	K	PHI	r	K–Y ratio	Increased tax
Benchmark	0	0.33	5.16	0.70	3.01%	3.00	0.00%
UHI	0.5	0.32	4.49	0.29	4.23%	2.78	8.59%

Notes: L is average effective labor; K is average asset holdings; PHI is PHI take-up ratio; Increased tax is the increase in payroll tax compared with the benchmark.

method has a redistributive effect because people with higher income pay more for the same expenditure coverage provided by the UHI. It is desired for social fairness although this tax also creates distortion. Our model with endogenous labor decision allows us to address the impacts of the distortion by comparing with a nondistortionary financing method. To determine a UHI policy, we face a trade-off between risk sharing and tax distortion.

In this section, we first investigate the case in which UHI covers 50% ($\omega = 0.5$) of medical expenditures and it is financed by a payroll tax. We compare it with the benchmark economy to illustrate the impacts of UHI. Then we further investigate different UHI policies with various ω and cases under a lump-sum tax (a nondistortionary tax) financing method. Impacts of UHI on welfare, asset holding, and PHI purchasing decisions with the two financing methods are discussed. Implications for private insurance (alternative designs) when UHI is introduced are also discussed.

5.1. Public Universal Health Insurance Provision—Deviation from the Benchmark

Aggregate features. Table 4 presents the aggregate features of the benchmark economy and the economy with UHI provision, which covers 50% of medical expenditure primarily and is financed by a payroll tax. We can observe clear crowding-out effects on asset holdings and PHI purchases. The PHI take-up ratio is only 0.29 in the economy with UHI, which is much lower than 0.7 in the benchmark economy. The capital–output ratio is also lower than it is in the benchmark economy (2.78 vs. 3.00) because of the lower average asset holdings. Moreover, the UHI provision leads to a higher tax burden—a additional 8.59% payroll tax is imposed on the working population. The substitution effect caused by the distortionary payroll tax decreases labor supply in the economy with UHI—the average effective labor hours become 0.32 compared with 0.33 in the benchmark.

Private health insurance take-ups and asset holdings. We observe a significant crowding-out effect on PHI purchases across wealth and generations when UHI is implemented (see Table 5). Given the assumption that PHI becomes complementary with the same proportional markup, we find a difference between wealth-rich and wealth-poor households. Those in the top-50% wealth group largely drop their PHI, whereas more in the bottom-50% group maintain their PHI. In the benchmark

TABLE 5. PHI take-up ratio: benchmark vs. UHI ($\omega = 0.5$)

Wealth group	Benchmark	UHI	Deviation
	Old generation		
Top 50%	77.41%	13.71%	−63.71%
Bottom 50%	63.47%	41.47%	−22.00%
	Young generation		
Top 50%	79.45%	13.80%	−65.65%
Bottom 50%	60.40%	44.73%	−15.66%

Notes: Deviation is the difference between the UHI economy and the benchmark.

when UHI is not available, almost 80% of the top-50% wealth group purchase PHI. However, in the economy where UHI is offered, only 14% of households in the top-50% group purchase PHI. In contrast to the top-50%, in the bottom-50% wealth distribution there are still more than 40% of households purchasing PHI when UHI is offered.

A significant crowding-out effect on asset holdings is also observed (Table 6). Nevertheless, we find that the trend of asset holdings across wealth groups is opposite to the PHI purchasing—the bottom 50% group drops asset holdings (by 16%) more than the top 50% (by 13%). This result suggests that when UHI is implemented, the wealth-rich tend to allocate more assets than private insurance in their portfolio, but the wealth-poor tend to rely on private and social insurance programs rather than on precautionary savings.

Portfolio choices. To understand the difference between the high-wealth and low-wealth households, we first need to understand the features of the two portfolio choices—assets and health insurance. Assets can insure against both income and health expenditure shocks, but are not state-contingent. To be well self-insured, households need to accumulate enough assets. PHI is state-contingent, and so households can be well insured against health expenditure shocks by simply

TABLE 6. Asset holdings: benchmark vs. UHI ($\omega = 0.5$)

Wealth group	Benchmark	UHI	Deviation
	Old generation		
Top 50%	9.195	8.008	−12.91%
Bottom 50%	1.397	1.180	−15.54%
	Young generation		
Top 50%	9.014	7.858	−12.82%
Bottom 50%	1.235	1.042	−15.61%

Notes: Deviation is the percentage change from the benchmark.

purchasing a PHI plan. However, unlike assets, PHI can do nothing with income shocks.

There are two channels through which the introduction of universal health insurance affects the private health insurance take-ups. First, compared to the benchmark case, where universal health insurance (UHI) is not available, private health insurance (PHI) is crowded out by UHI, because the expenditure risk is reduced. This risk reduction lowers PHI take-up ratio in aggregate, i.e., has a crowding-out effect (risk-reduction channel). Second, PHI becomes more affordable with higher UHI coverage because the expected out-of-pocket medical expenditure is lower and so the PHI premium is lower. More people on the average purchase PHI rather that self-insuring by accumulating the non–state contingent asset because the price of PHI is cheaper, i.e., a crowding-in effect (substitution channel).

Table 5 and 6 compare the PHI take-ups and asset holdings between two wealth groups (top 50%, wealth-rich, vs. bottom 50%, wealth-poor) and show that the two channels work differently across the wealth groups. When UHI provides primary coverage, the wealth-rich allocate more resources to self-insurance (savings), whereas the wealth-poor rely more on complementary PHI. That is, risk-reduction channel dominates in the wealth-rich group, whereas the substitution channel is stronger in the wealth-poor group. This is because, to the low-wealth households, it is difficult to accumulate enough assets for self-insurance. In addition, out-of-pocket medical expenditure is still a burden to them as long as the UHI requires co-payments (ω is not one). Because PHI is cheaper now, they are more willing to maintain PHI, compared with the wealth-rich, to insure against the medical expenditure shocks.

To the wealth-rich, with the UHI provision, the uncertain out-of-pocket medical expenditures become relatively small, and the benefit of purchasing a complementary PHI plan that covers a proportion of out-of-pocket expenditures becomes unattractive to them. They can more easily use their assets to replace the complementary PHI; poor households do not have this option. Moreover, the rate of asset return r is higher with the UHI provision because the aggregate capital is crowded out. Given the normal assumptions of preferences, the high-wealth will respond more to the higher asset return (by increasing asset holdings) than the low-wealth. Therefore, we observe a smaller percentage reduction in asset holdings but a sharper decline in PHI take-ups among the households in the top-50% wealth group.

The result is based on our assumption of PHI design when UHI is introduced. We will discuss alternative PHI plans in Section 5.5. This finding also indicates that the wealth-rich households might be sensitive to price changes in PHI. The effect of price changes on PHI take-ups will also be discussed in Section 5.5.

Welfare. The UHI's redistribution effect on wealth is not clear, and the wealth distribution might be even more unequal, because the gap in asset holdings between the high-wealth and the low-wealth is enlarged. However, we observe a clear redistribution effect on welfare between young and old generations and between high- and low-wealth groups. Table 7 summarizes the results.

The main factors of UHI provision that affect welfare are as follows: (1) *Risk reduction*: It increases an individual's ability to insure against medical expenditure risk because the general expenditure coverage is increased by UHI when PHI has a limitation on the coverage.
(2) *General equilibrium effect*: The reduction of precautionary savings will increase the interest rate and lower the wage rate.
(3) *Tax effect*: The increased burden on payroll tax or income tax used for financing the UHI program has an income effect and a distortion effect that discourages effect labor supply and asset holdings.

In general, the old generation gains more than the young generation from the UHI provision because its UHI coverage is subsidized. The young generation need to share old people's insurance cost with the payroll tax financing scheme. Moreover, we can also observe that the low-wealth people gain more than the high-wealth. One reason is that the benefit of risk reduction is larger for low-wealth people, who are unable to self-insure against medical shocks, but smaller for high-wealth people, who are already self-insured. In addition, the high-wealth people (who are rich in the model because they consistently have higher labor productivity and so higher labor income) are forced to pay more for the same coverage offered by UHI.

5.2. Universal Health Insurance Policies: Risk Reduction vs. Tax Distortion

With various settings of the UHI coverage rate ω (from 0.4 to 0.9) under the payroll-tax financing scheme, the results are consistent with our preceding analysis (see the lines in Figure 3). We can see that a UHI program with a larger ω crowds out more PHI purchases and asset holdings, and its higher payroll tax rate reduces labor supply.

Payroll tax financing vs. lump-sum tax financing. If the UHI is financed by nondistortionary lump-sum tax, the cost of UHI implementation is equally shared by all agents in the economy, regardless of wealth level and age. This method is rarely adopted to finance the UHI or other social insurance programs, because it does not match the common concept of "social fairness." We, however, find that this nondistortionary financing method helps us disentangle the distortion created by a distortionary payroll tax.

We perform the simulations with ω from 0.4 to 0.9 under the lump-sum financing scheme. The results are represented by the red lines in Figure 3. Figure 3 shows that PHI and asset holdings are also crowded out (compared with the benchmark with $\omega = 0$), but they are less crowded out than under the payroll tax financing method. Labor hours are not decreased as when the UHI is financed by the distortionary payroll tax because the lump-sum tax does not distort the wage rate. Instead, it creates a negative income effect that increases the incentive to work more.

TABLE 7. Welfare comparison

Rich vs. poor				Young vs. old			
Wealth group	Benchmark	with UHI $\omega = 50\%$	Deviation (CEQ)	Age group	Benchmark	with UHI $\omega = 50\%$	Deviation (CEQ)
Top 50%	−33.269	−33.323	−0.41%	Old	−47.79	−45.83	11.09%
Bottom 50%	−48.626	−47.078	8.49%	Young	−39.24	−38.79	2.94%

Note: Welfare is measured by lifetime value with equilibrium distribution. Deviation is calculated by using the certainty equivalent consumption (CEQ) measure: CEQ $= (V_{\text{UHI}}/V_{\text{benchmark}})^{1/[\phi(1-\mu)]}$.

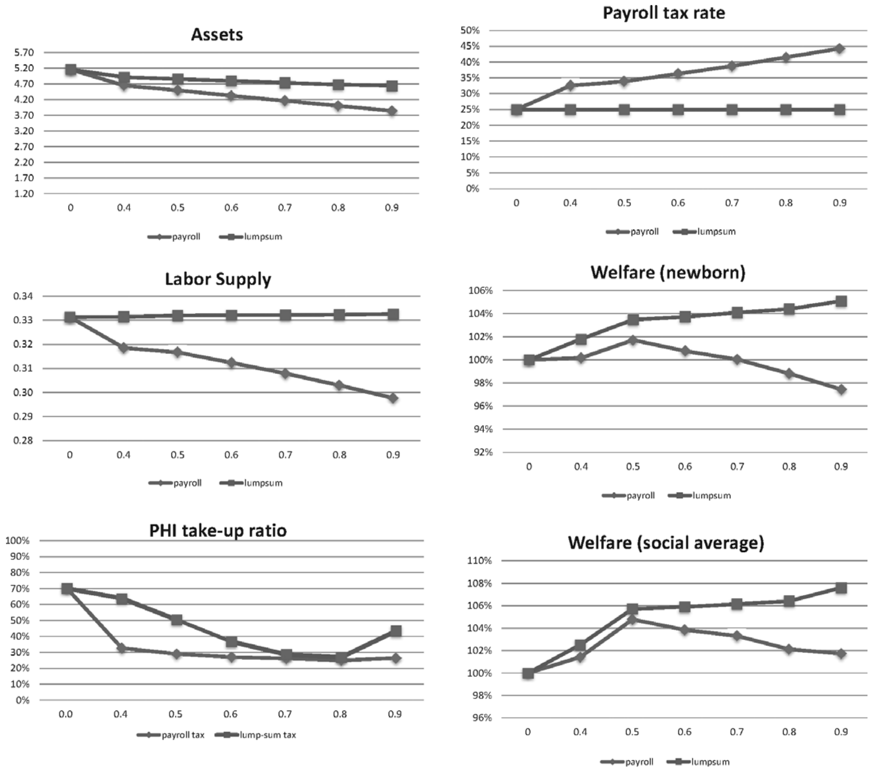

FIGURE 3. Results with various UHI coverage rates ω.

Asset holdings. Figure 3 presents the aggregate asset holdings in the benchmark economy and the economy with UHI provision. We can observe clear crowding-out effects on asset holdings for both financing methods. With lump-sum tax financing, we clearly see that providing UHI without distortion in the economy reduces the precautionary savings motive, so that agents' asset holdings on average are lower. When the payroll tax financing method is used, the volatility of after-tax earnings that households face is reduced, and so the precautionary saving motive becomes even lower.

Labor supply. In Figure 3, we also show effects of two different financing methods on the agent's average labor supply and equilibrium payroll tax rates. We clearly see the nondistortionary property of the lump sum tax, but because the lump sum tax will change the agent's asset holdings and consumption, it will have a minimal effect on labor supply through the income effect, so that the labor supply does not stay constant at the benchmark level. On the other hand, when the government uses the payroll tax to finance the UHI, the increase in the payroll tax rate will distort the labor supply decision, and as the tax rate increases, the labor supply monotonically decreases — the substitution effect dominates even though asset holdings decrease so that agents have an incentive to work more.

Private health insurance take-ups. In Figure 3, we observe a significant crowding-out effect on PHI purchases in the economies when UHI is implemented. Although the premium of PHI becomes cheaper as UHI coverage ω increases, there is less space that PHI can cover. It confirms that the substitution effect (PHI being cheaper) is dominated by the crowding-out effect. Similarly to asset holdings, we also find that payroll tax financing crowds out more PHI take-ups than the lump-sum tax financing scheme. Note that when $\omega = 0.9$ and the PHI becomes very cheap, the PHI take-up ratio increases a bit but is still lower than that in the benchmark.

Welfare implications. To understand the impact on welfare, we adopt two measures of social welfare: (1) ex ante expected lifetime discounted utility of a newborn agent and (2) average cross-sectional expected lifetime utility. Again, we use the certainty equivalent consumption (CEQ) to calculate welfare deviation from the benchmark to economies with various UHI coverage across different financing schemes (lump-sum tax vs. payroll tax).[6] Figure 3 presents the result with the first welfare measure (newborn babies) and the result with the second welfare measure (social average value). Note that welfare with lump-sum tax financing is computed to disentangle the distortionary effect of payroll tax. Any gaps between social welfare with lump-sum tax and payroll tax reflect the aggregate welfare effect of the distortion.

If we use social average lifetime value to measure social welfare (the bottom one in the right panel of Figure 3), the social welfare is always higher with any positive UHI coverage than in the benchmark economy where UHI coverage is absent. Moreover, with lump-sum tax financing, the welfare is monotonically improving over the UHI coverage, whereas with a payroll tax financing scheme, the welfare is improving up to coverage around 50% and then deteriorates afterward, so that the social welfare as a function of the UHI coverage shows an inverse U shape. This implies that marginal social gain (benefit) is bigger than the marginal social cost (distortion) up to the UHI expenditure coverage of 50%, but the marginal cost of tax distortion outweighs the marginal gain when the UHI coverage becomes higher.

We also use another measure of social welfare, expected value of newborn babies, for the comparison. The pattern is the same as with the measure of social average value, but we can see that the social welfare is even lower than the benchmark when the UHI coverage is higher than 70%.

As we found in Figure 3, allowing endogenous labor decisions plays an important role here. It is crucial to model the endogenous labor supply for carefull investigation of the welfare implications of a policy when the policy requires an additional distortionary tax to be introduced for government budget balance. In our analysis, the payroll tax–financed UHI does not necessarily leads to higher welfare.

It is not hard to understand the general welfare effect. In the case that we analyzed, as being primary health insurance, PHI has a limitation on covering full medical cost. From the U.S. data, we find that the PHI coverage is about 70% on average. With the UHI serving as the primary insurance, people can use PHI as supplementary/complementary insurance to further reduce the uncertainty, which improves welfare. The crowding-out on asset holdings caused by the UHI provision and the tax distortion also contribute to welfare in the environment with incomplete markets. In the benchmark economy, because of market incompleteness, precautionary savings lead to an overaccumulation of capital (and consequently oversupply of labor). The reduction in capital resulted from UHI provision adjusts the capital and makes the aggregate better off. However, we also observe that the tax distortion effect can outweigh the additional welfare gain under the payroll tax financing scheme, whereas it does not do so under lump-sum financing. In our numerical exercise, we find when the UHI expenditure coverage rate is higher than 50%, the additional distortion effect outweighs the additional welfare gain. The rate (50%) is actually much lower than the OECD average.

5.3. Sensitivity Test: Risk Aversion

The level of risk aversion, which is governed by the parameter μ in the utility function, is an important determinant of a household's saving/health insurance purchasing decisions and affects the welfare measurement of our policy experiments. In the benchmark analysis, we set μ at 2, which is used by many previous studies. To test the robustness of our results, we also perform these experiments with different levels of risk aversion, particularly $\mu = 1.5$ (less risk averse) and $\mu = 3$ (more risk averse).[7]

With higher risk aversion $\mu = 3$, we find that the comparison across various UHI policies and financing methods is the same as with $\mu = 2$, except that the welfare is measured by social average value. The social welfare under some UHI policies (when ω is 0.4 and 0.5) is higher with a payroll tax financing scheme than it with a nondistortionary lump-sum tax scheme. This finding verifies the result from many previous studies on capital tax with incomplete markets, e.g., Hubbard and Judd (1986), Aiyagari (1995), Imrohoroglu (1998) and Conesa et al. (2009). Because of market incompleteness, precautionary savings lead to an overaccumulation of capital (and consequently an oversupply of labor). The reduction in capital resulting from UHI provision adjusts the capital and makes the aggregate better off.

With payroll-tax financing, assets are further reduced when UHI is introduced because the tax distortion reduces the labor supply and so lowers down the labor income fluctuation and the marginal product of capital (i.e., asset return), which further discourages asset holding. Even we still find an inverse U shape of welfare pattern across the policies with various ω (see Figure 4).

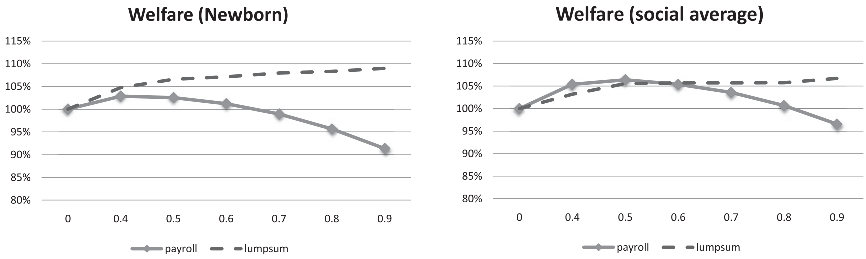

FIGURE 4. Welfare comparison: higher risk aversion $\mu = 3$.

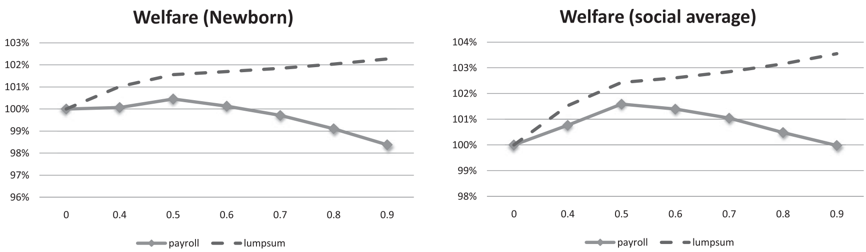

FIGURE 5. Welfare comparison: lower risk aversion $\mu = 1.5$.

When households are less risk-averse (with $\mu = 1.5$), we can clearly observe that a the comparison across various UHI policies (various ω) and financing methods is the same as it with $\mu = 2$.

In both cases, we still find that a UHI policy with ω above 50% leads to lower social welfare (see Figure 5). All these tests suggest that the optimal UHI coverage ratio with payroll tax financing would be lower than the current OECD average (70%).

5.4. Discussion: Demand for Private Health Insurance When Universal Health Insurance is Introduced

In the preceding analysis, when UHI is introduced, PHI is assumed to be a complementary plan, which reduces out-of-pocket medical expenditures. We also assume its markup is the same as the primary PHI when UHI is not available. Given the assumptions, the model predicts that the complementary PHI take-up ratio of the rich is low, even lower than that of the poor, which is seemingly counter to the common impression. In the real world, there exist supplemental insurance plans that cover higher-quality services and/or medical treatments, which are not covered by the public UHI. It is true that rich individuals might demand more high-quality/advanced medical services and purchase supplemental insurance plans. This subsection provides a discussion and relaxes the assumptions in our analysis to investigate the demand of PHI when UHI is introduced.

Complementary vs. supplemental: Catastrophic insurance. To investigate the impact of a supplemental insurance plan when UHI is implemented, rather than a complementary plan that covers a proportion of out-of-pocket payments, we design a catastrophic health insurance plan that mimics a complementary plan, although we do not have the aspect of quality difference in medical services. This insurance plan potentially attracts the rich, because catastrophic health shocks, even with a small probability, are still harmful to the rich when they really happen—for example, cancer, major burns, and AIDS.

In the model, private catastrophic health insurance, not like UHI, which covers a proportion of all types of medical expenditures, provides full coverage of the out-of-pocket expenditures when the largest medical shock happens ($x = x_{m,i}$, $i \in \{o, y\}$), but zero coverage when other medical expenditures happen. Based on the MEPS data, the highest (catastrophic) state of medical expenditure in our model is 160% of average annual income for the young, and 227% of average annual income for the elderly. Suppose that when UHI is implemented, private insurance companies provide supplemental catastrophic health insurance instead of complementary insurance. A young agent's budget constraint becomes

$$\begin{aligned}\text{Wel}_y &\equiv (1 - \tau_{ss} - \tau_n)\, wzn + [1 + (1 - \tau_k)\, r]\, a - (1 - \omega)x \\ &\quad + (1 - \omega)x(i_{HI})(I_{x=x_{m,y}}) - Tax,\end{aligned}$$

where $I_{x=x_{m,y}}$ is an indicator, which has a value of 1 if the catastrophic medical expenditure $x = x_m$ happens, and 0 otherwise. The change in an old agent's budget constraint is similar to that for the young agent. The catastrophic health insurance will make a payment $(1-\omega)x$ if the value of $I_{x=x_{m,o}}$ is 1. The premium of the private catastrophic health insurance is defined as $q(x) = (1+\psi)(1-\omega)E[x'(I_{x'=x_{m,i}})|x]$, where $i \in \{y, o\}$ and ψ is the proportional markup.

We then perform experiments to investigate this scenario. The third column in Table 8 presents the result of PHI take-up ratios of the top 50% wealth group and the bottom 50% wealth group (with a coverage rate $\omega = 0.5$). We find that the wealth-rich people have a higher tendency to purchase the catastrophic PHI (with a take-up ratio 80.29%) than the poor (with a take-up ratio 52.20%). As we expect, this insurance plan can still attract the rich because catastrophic health shocks are also harmful to them. Compared with our original assumption of a complementary insurance (the second column in Table 8), the result implies that supplemental insurance would be more attractive when UHI was available. Particularly, it is more attractive to the rich than a complementary plan because the rich can easily use their wealth to insure against normal medical expenditure shocks.

Moreover, we show in Figure 6 that the the patterns of UHI impact are similar to the previous analysis even with that the rich have a higher take-up ratio of catastrophic PHI than the poor. As in our previous analysis, we still find that with considering the trade off between risk sharing and tax distortion, the UHI expenditure coverage rate ω should not be high (no higher than 0.5). Regarding

TABLE 8. PHI take-up ratio under UHI ($\omega = 0.5$): complementary vs. catastrophic

Wealth group	No UHI Benchmark	UHI available	
		Complementary PHI	Catastrophic PHI
Top 50%	79.04%	13.79%	80.29%
Bottom 50%	61.02%	44.06%	52.20%

the PHI market, we can see that there are still two channels through which the introduction of UHI affects the PHI take-ups. However, the crowding-out effect is smaller in this scenario.

Price change in private health insurance. Because our model predicts that the rich can more easily replace PHI with their assets, we expect that they are more sensitive to price changes in PHI. If we assume that after the public UHI provides primary coverage, private insurance companies can reduce their administration cost by only providing complementary insurance, the markup of PHI can be lowered down.

We investigate a scenario in which the markup of the complementary PHI to UHI (ψ) is 50% lower than for the primary PHI when UHI is not available. The premium of the PHI is

$$q\,(x) = (1 + 0.5\psi)\;E[\omega_p(x') \cdot (1 - \omega)x'|x]. \tag{5}$$

We also perform quantitative experiments to investigate this scenario. The second column in Table 9 shows that the complementary PHI take-up ratios of the

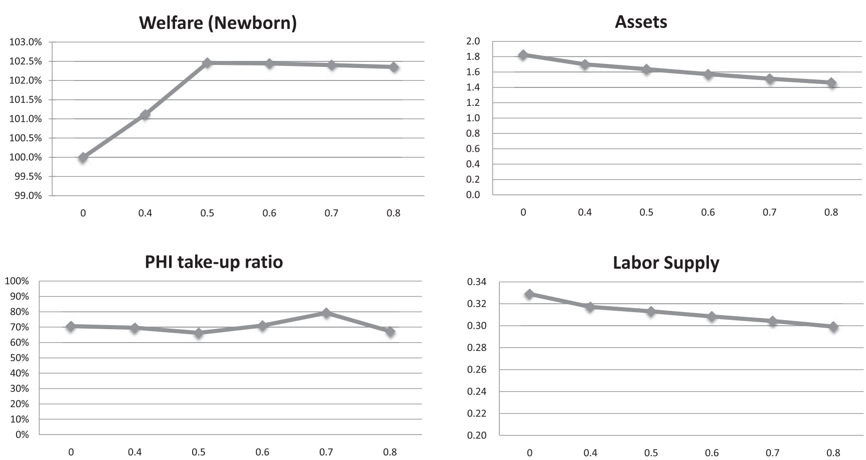

FIGURE 6. Various policies of UHI with supplemental catastrophic PHI.

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TABLE 9. Complementary PHI take-up ratio (UHI $\omega = 0.5$)

	PHI take-up ratio	
Wealth group	Original markup (ψ)	Lower markup (0.5ψ)
Top 50%	13.79%	95.57%
Bottom 50%	44.06%	83.83%

top 50% wealth group and the bottom 50% wealth group with a lower markup (under a UHI coverage rate $\omega = 0.5$). Compared with our original analysis (the first column in Table 9), the cheaper complementary PHI attracts more individuals to purchase it. Particulary, the rich now have a higher take-up ratio (95.57%) than that of the poor (83.83%). This result verifies our expectation that the rich are more sensitive to PHI price changes.

We also show in Figure 7 that the patterns of UHI impacts are similar to those in our previous analysis even when the rich have a higher PHI take-up ratio than the poor. The UHI policy with ω set at 0.5 is still suggested. Regarding the PHI market, we can see that there are still two channels through which the introduction of UHI affects the PHI take-ups. However, the crowding-out effect is smaller in this scenario, and in general the level of take-ups is high because of the cheaper price.

Some evidence. Laschober et al. (2002) studied the trend in Medicare supplemental insurance during 1996–1999. During this period, an increased popularity of Medicare HMOs and double-digit increases in Medigap (individually

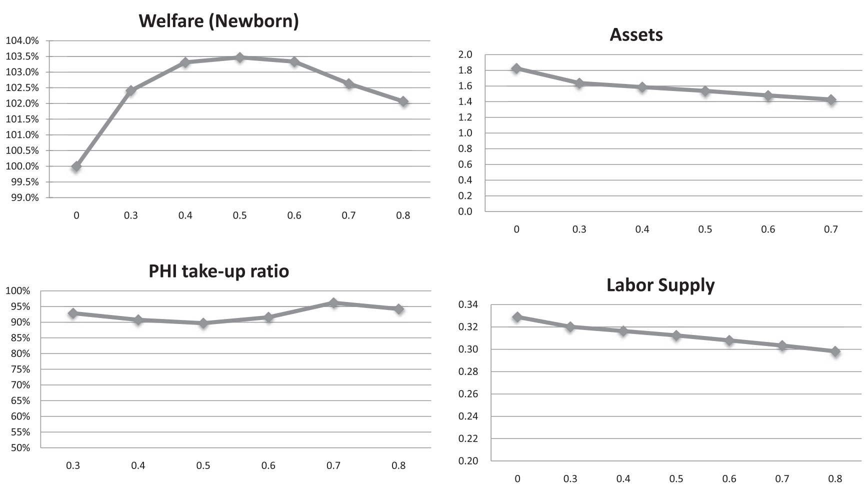

FIGURE 7. Various policies of UHI with cheaper complementary PHI.

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purchased private Medicare supplemental insurance) premiums were observed.[8] Both Medicare HMOs and Medigap are considered supplemental insurance to Medicare. They found that the high, income group (more than $30,000) experienced a significant decline in total Medicare supplemental insurance coverage, and the significant decline was not found in other lower income groups.[9]

Although we do not focus on the Medicare supplemental insurance market, this empirical finding supports our model prediction that the rich are more sensitive to the price of PHI because they have an option of self-insurance with assets, but the poor do not.

6. CONCLUSION

In this paper, we provide a quantitative investigation of implications of public UHI provision in an economy in which a private insurance market is available. In particular, we analyze impacts on private insurance purchases, asset holding, portfolio choice decisions, labor supply decisions, and social welfare. UHI policies with various co-insurance rates are quantitatively compared. In addition, both distortionary (payroll tax) and nondistortionary (lump-sum tax) methods for financing the UHI are also discussed to address tax distortion and corresponding welfare implications. We allow both endogenous insurance and labor decisions in our analysis. We find that the addition of endogenous labor has important welfare implication when the UHI is financed by the widely used payroll tax —a trade-off between risk sharing and tax distortion.

Our results show that providing UHI has a clear crowding-out effect on asset holdings. If the type of PHI and its proportional markup are maintained, as in the case without UHI, a significant decline in PHI take-up ratio is suggested, because individuals can more easily use assets for self-insurance when UHI already provides primary coverage. The redistribution effects on welfare across generations and across wealth groups are observed—the old gain more than the young, and the poor gain more than the rich which is consistent with the redistribution effect of a payroll tax. We also identify the distortion caused by the payroll tax for financing the UHI, which reduces labor supply and further crowds out PHI and asset holdings. Moreover, we compare UHI policies with various expenditure coverage rates, and the result suggests that the rates in most OECD countries might be too high when taking into account the tax distortion. We find when the UHI expenditure coverage rate is greater than 50%, the additional distortion loss outweighs the additional welfare gain from risk sharing.

We also discuss the demand for PHI when UHI is introduced. We find that when UHI provides primary coverage and PHI becomes complementary, wealth-rich individuals can more easily have their assets substitute the complementary PHI, and therefore have less incentive to purchase the PHI and are more sensitive to its price change. On the other hand, individuals with low wealth do not have this option and are less sensitive to the price change. We illustrate that if the markup of PHI can be lowered when UHI provides primary coverage, insurance companies can still attract their customers to purchase the complementary PHI. We also find that a supplemental PHI plan, which covers items not covereds by UHI, would attract the rich more. We illustrate this by designing a catastrophic PHI. Some empirical findings from the market for Medicare supplemental insurance are consistent with our model prediction, and the issue will be worth further empirical studies to provide precise empirical tests.

NOTES

1. Aiyagari and McGrattan (1998) study how government debt policy can change the net supply of assets for self-insurance. Imrohoroglu et al. (1995), Conesa and Krueger (1999), Huggett and Ventura (1999), Storesletten et al. (1999), and Huggett and Parra (2010) study the role of social security as a partial insurance and redistribution device. Domeij and Heathcote (2004) and Nishiyama and Smetters (2005) consider the distributional effects of mix of tax instruments. Hansen and Imrohoroglu (1992) conduct quantitative explorations of unemployment insurance.

2. Regarding the distortionary effects of marginal income taxes in the incomplete market models, Heathcote (2005) and Domeij and Heathcote (2004) also model a household's endogenous choice of labor supply in the incomplete market environment in order to precisely measure the distortions created by proportional labor taxes when the effects of social policy are studied. We follow the endogenous labor setting in our analysis.

3. We do not model the annuity market for the old in this economy, and assume that all bequests are accidental and collected by the government, which reduces the need of the lump-sum tax to balance the government budget (or even makes TAX as a transfer).

4. The utility function given by equation (4) implies that labor supply can be expressed as a function of consumption and effective wage rate: $n = 1 - \frac{(1-\phi)(1+\tau_c)c}{\phi(1-\tau_n-\tau_{ss})wz}$.

5. See similar settings in Aiyagari (1995) and Hubbard et al. (1995), for example.

6. $\text{CEQ} = (V_{\text{UHI}}/V_{\text{benchmark}})^{1/[\phi(1-\mu)]}$.

7. We also try some smaller values for μ, e.g., $\mu = 1$. However, when μ is close to 1, households become less risk-averse and the PHI take-up ratio is always lower than 70% (our calibration target) even with a zero mark-up in the PHI premium in the benchmark economy. Therefore, we cannot compare these cases with our benchmark analysis.

8. See p. W135 in Laschober et al. (2002).

9. See the table EXHIBIT 2 in Laschober et al. (2002). On p. W129, they explained the trend of the high-income group by the decline in take-up ratio of Medigap (-4.2 percentage points) not being offset by the increased Medicare HMO enrollment (+3.1 percentage points). However, on the same page, W129, they stated that the poorest group had only relatively small declines in Medigap and had gains across other resources.

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