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COVERAGE EXPANSION OF UNIVERSAL HEALTH CARE AND ITS IMPACTS ON HEALTH INSURANCE MARKET AND WELFARE: THE CASE OF SOUTH KOREA*

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Abstract

We examine how the coverage expansion of universal health care (UHC) affects the private health insurance (PHI) market and welfare using a quantitative macroeconomic model. Reduced medical expenditure and risk by the UHC coverage expansion leads individuals to save less and purchase less of PHI. The raised UHC premium to finance the coverage expansion discourages individuals to work since UHC is primarily financed by an earmarked payroll tax. Although the aggregate level labor, capital, output, and PHI take-up ratio decrease, welfare increases monotonically with the coverage expansion with the redistribution effect toward the old and the poor.

Keywords: Universal Health Care, Private Health Insurance
JEL classification Codes: C68, E69, H51, I13, J21.

I. *Introduction*

In recent years, increasing global attention and effort have been put forward toward provision of universal health care (UHC), culminating in 2015 when United Nations Member States included achieving UHC as a target in one of the 17 Sustainable Development Goals. Not only is UHC pushed forward as an essential instrument to enhance and equalize welfare as well as health care,[1] but some developing countries even pursue it as a catalyst for economic growth based on a belief that a consequential health improvement can lead to a positive

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[1] In the literature, high medical and drug bills are viewed as one of major threats to household's financial stability and welfare. See, for instance, Domowitz and Sartain (1999) and Gross and Notowidigdo (2011).

economic outcome.[2]

In this paper, we investigate the macroeconomic impacts—with extra attention to how individual behaviors of savings and purchase of private health insurance (PHI) are changed—and welfare implications of the coverage expansion of UHC, taking a case of Korea. Korea launched a single-payer (public) healthcare system, National Health Insurance (NHI), in 1977, and extended it to the whole population in just 12 years to complete the UHC achievement process. While Korea is often cited as an exemplary country for the UHC achievement, a high level of household's out-of-pocket (OOP) medical expenditure remains a huge problem, which leaves many households with no choice but relying on PHI.[3] To overcome this problem Korean government announced a policy aimed to increase the coverage ratio of NHI to 68% by 2020 and to 70% by 2025 in 2015.[4]

We present a dynamic stochastic general equilibrium model with both UHC and PHI available, which is characterized as follows. First, agents confront three types of idiosyncratic shocks—medical expense shock, labor productivity shock, and disability shock, which makes them ex-post heterogeneous. Second, UHC—called NHI in Korea—covers a preset fraction of every agent's medical expense, which is primarily financed by an earmarked payroll tax referred to as NHI premium. Last but foremost, every agent can choose to purchase a private health insurance (PHI) that can further reduce the out-of-pocket medical expense.

We calibrate our model to the Korea's economy in 2016 where the coverage ratio of NHI is set to 63% and the PHI premium is determined so that the PHI take-up ratio reflects the data. We start with the examination of which types of individuals purchase PHI. Since the multiple state variables make it difficult to study which state variable contributes to the PHI purchase, we draw a sample of a million agents from the invariant distributions of the young and the old, and then perform probit regressions to examine how each individual characteristic affects the purchase of a PHI. We find that a higher level of medical expense or savings induces a higher likelihood of purchasing a PHI for the old. This pattern, however, does not hold for the young: while a higher medical expense as well as the disability induces a higher likelihood of the PHI purchase, a higher level of savings results in a lower likelihood. The negative impact of savings on the young agent's purchase of PHI derives from the fact that savings can be utilized to insure against the medial expense shock: agents with a higher level of savings can effectively smooth consumption by dissaving, without resorting to PHI.

Next, we perform a model experiment to investigate the macroeconomic impacts and welfare implications of UHC coverage expansion. To that matter, we calculate and compare the steady state equilibria of the model economies that differ from our calibrated model economy—the benchmark economy with the NHI coverage ratio of 63.2%, reflecting the 2016 Korea's—only in the NHI coverage ratio. In particular, we consider the cases in which the NHI coverage ratio is increased to 70, 80, and 90%. When the NHI coverage ratio is increased, the NHI premium should be increased to meet the increased NHI budget. The decrease in the after-NHI-premium wage, in turn, reduces the agent's incentive to work, which brings about

[2] A substantial body of studies, including Strauss and Thomas (1998), Bhargava et al. (2001), Bloom and Canning (2003), and Bloom et al. (2004), have drawn a causal link between health and productivity, which substantiates the claim.

[3] According to Lee (2015), the ratio of OOP medical expenditure to total medical expenditure was 36% in Korea as of 2012, which was significantly higher than the average ratio, 21%, of OECD countries.

[4] As of 2016, the coverage ratio of NHI is 62.6%.

decreases in aggregate labor and the employment rate. Importantly, the expansion of the NHI coverage reduces the uncertainty from medical expense shock, which leads to a decrease in aggregate capital as well as the PHI take-up ratio. Since both production factors—labor and capital—decrease in response to the expansion of NHI coverage, so does aggregate output.

While the UHC coverage expansion results in a decline of aggregate output, it does not necessarily mean a decrease in welfare. The comparison of the average welfare of agents across the model economies with different NHI coverage ratios suggests that welfare increases monotonically in the NHI coverage ratio. To further investigate the welfare redistribution effect of the UHC coverage expansion, we divide and compare each of the whole population, the young, and the old into two groups by the level of assets: the top 50% asset-group (the rich) and the bottom 50% asset-group (the poor). Our analysis shows that the UHC coverage expansion redistributes welfare toward the old and the poor. That is, when the UHC coverage expansion is placed, (i) the welfare of the old increases more than that of the young; and (ii) the welfare of the poor increases more than that of the rich.

Since Kotlikoff (1989) pioneered the view that the medical expense shock is a crucial factor in accounting for the household's decision on savings, researchers started to incorporate the medical expense shock into the dynamic equilibrium models with heterogeneous agents. For instance, Palumbo (1999), who attempted to explain the elderly individual's sluggish dissaving pattern after retirement, proposed a version of Aiyagari-Bewley type model where agents are exposed to uncertain medical expenses. Using a similar type of model, Jeske and Kitao (2009) analyzed the welfare impact of the regressive U.S. tax policy on PHI, and Hsu and Lee (2013) claimed that public provision of UHC would have a crowding-out effect on asset holdings. Recently, Hsu and Yamada (2012), Hsu et al. (2015), Hsu and Liao (2015), and Lim (2016) dealt with the UHC financial stability issue that might arise from population aging.

In the current literature, however, only limited attention has been paid on the coverage expansion of UHC, despite potentially important impacts that it might have on the economy. A rare exception is Lim (2017), who attempted to quantify the macroeconomic impacts of the coverage expansion of UHC in an aggregate economy framework. However, we find that the absence of PHI could result in a systematic overestimation of the old's welfare and underestimation of the young's welfare. We attempt to correct this issue by introducing a PHI market into our model, following Hsu and Lee (2013).

The closest to this paper is Hsu and Lee (2013), who investigated the impacts of provision of UHC in an economy without an established UHC, taking a case of U.S. Unlike Hsu and Lee (2013), this paper aims to analyze the impacts of coverage expansion of UHC in an economy with an already established UHC, taking a case of Korea.

The remainder of the paper is organized as follows. The next section presents the model, and section 3 describes our calibration strategy. Section 4 is assigned to the design and the results of our policy experiment that aims to quantify the macroeconomic impacts and welfare implications of UHC coverage expansion. Finally, section 5 concludes the paper.

II. *Model*

The model adopted in the paper closely follows Hsu (2013) and Lim (2017). Time is discrete and infinite. The economy is populated by a continuum of measure one agents that are divided into two groups by their age: the young generation and the old generation. The young generation is considered as the working-age population and the old generation as retirees. Young agents become old with probability π_o and old agents die with probability π_q. At the time old agents die, the aggregate assets of theirs, b, are equally distributed to the whole population. In addition, new young agents of the same number enter the economy, which makes the population measure constant over time.[5]

Agents in each generation are ex-ante identical but they are exposed to idiosyncratic shocks that make them ex-post heterogeneous. Young agents face shocks in labor productivity, z, medical expense, m, and disability condition, d, which are positively correlated over time. Disability condition d is binary, taking 1 when severe health conditions preclude agents from working and 0 otherwise. We assume that the shocks evolve over time according to the finite-state Markov processes with transition probability distribution functions: $P^Y(z'|z)=Prob(z_{t+1}\leq z'|z_t=z)$ and $P^Y(m', d'|m, d)=Prob(m_{t+1}\leq m', d_{t+1}=d'|m_t=m, d_t=d)$, where t denotes time. Note that we allow for the inter-dependency in the shock processes of m and d to capture the tendency of agents who pay higher medical expenses being exposed to higher risks of being disabled.[6] Old agents face a single shock in medical expense, $\tilde{m}$, which evolves over time according to a finite-state Markov process: $P^O(\tilde{m}'|\tilde{m})=Prob(\tilde{m}_{t+1}\leq\tilde{m}'|\tilde{m}_t=\tilde{m})$

Agent's preferences are expressed in terms of discounted expected utility over sequences of consumption and working hours, $(c_t, h_t)_{t=0}^{\infty}$:

$$U(c, h)=\mathbb{E}_0\sum_{t=0}^{\infty}\beta^t u(c_t, h_t)$$

$$u(c_t, h_t)=\frac{c_t^{1-\sigma}-1}{1-\sigma}-B\frac{h_t^{1+1/\gamma}}{1+1/\gamma}$$

where β denotes the discount factor, σ is the coefficient of relative risk aversion, B is the parameter that governs the level of disutility from working, and γ is the elasticity of labor supply. We adopt the indivisible labor assumption as in Rogerson (1988) and Chang and Kim (2006): h_t takes 0 in case that agents do not work either voluntarily or involuntarily and takes $\bar{h}$ in case that agents work. An employed agent with labor productivity z_t provides her labor to a firm and earns labor income $w_t z_t \bar{h}$ in return, where w_t is the market wage rate for an efficiency unit of labor.

There are two types of social security programs operated by the government: the national health insurance (NHI) and the social insurance (SI). The NHI, which is designed to reduce the agents' financial burden from the medical expense, is a universal welfare policy: the NHI covers a fraction, f, of the realized medical expense of every agent, *regardless of* the agent's wealth, age, and working status. To finance it, the government collects the compulsory NHI premium from the entire population in two different forms depending on the agent's working status. The employed pay the NHI premium that is proportional to their labor income; an employed agent with labor productivity z_t pays $\tau_N w_t z_t \bar{h}$ at time t, where τ_N denotes the NHI

[5] Given these assumptions, the steady-state measures of the young and the old generations are $\pi_d/(\pi_o+\pi_d)$ and $\pi_o/(\pi_o+\pi_d)$, respectively.

[6] Due to the lack of data, the labor productivity shock is assumed to be independent of the other shocks.

premium rate for the employed. The non-working agents pay the fixed amount of the NHI premium, p_N.[7] The SI, on the contrary, is a selective welfare policy in that only agents whose disposable income is lower than a preset minimum cost of living, $\underline{y}$, are entitled to receive the subsidy as in Hubbard et al. (1995). The SI is financed by consumption tax, labor tax, and capital tax. We assume that the government has separate and balanced budgets for the NHI and the SI.

The financial market is incomplete in that only the non-state contingent claims are available, and agents face a borrowing constraint, $a_t \geq \underline{a}$, as in Bewley (1986), Huggett (1993), and Aiyagari (1994). Risk averse agents can accumulate assets to partially insure themselves against any combination of idiosyncratic shocks (z, m, d), of which the rate of return, r, is competitively determined at the equilibrium. In addition, agents can choose to purchase a private health insurance (PHI) that covers a fraction, f_p, of the realized NHI-covered medical expense; the net out-of-pocket medical expenditure of an agent with a PHI is $(1-f_p)(1-f)m'$,[8] where the realized medical expense of the agent is given by m'. We adopt the *adjusted* community rating as a basis for premium calculation in that the insurance provider must offer health insurance policies at the same premium to all agents in a generation regardless of their history of medical expense whereas different levels of premiums can be set to different generations.[9] q_y and q_o denote the premiums for young agents and old agents, respectively.[10] It is assumed that total profit (or loss) of the private insurance providers, ν, are equally distributed to the entire population in the form of dividend.

The production sector consists of a publicly owned representative firm that produces consumption goods in accordance with constant returns to scale:

$$Y_t = L_t^{\alpha} K_t^{1-\alpha} \tag{1}$$

where L_t and K_t denote aggregate labor and capital that the firm puts into production at time t, and α denotes the labor income share. The firm does not accumulate its own capital; rather, it rents capital from the financial market at the rental rate of r_t. The capital used in production depreciates at the rate, δ. The factor prices are competitively determined at the corresponding factor markets. Given a wage rate for an efficiency unit of labor, w_t, and a rental rate for capital, r_t, the firm maximizes its profit by optimally choosing the factor inputs as follows:

$$\max_{L_t, K_t} L_t^{\alpha} K_t^{1-\alpha} - w_t L_t - (r_t + \delta) K_t \tag{2}$$

The time frame of our model is as follows. Agents start each period with a pre-determined savings a. At the beginning of each period, the labor productivity shock z is realized and agents choose to buy a PHI or not, based on the last period's medical expense and disability condition (m, d). Then, the idiosyncratic shocks, (m', d', z) for the young and $\tilde{m}'$ for

[7] The non-working agents refer to young agents not working, either voluntarily or not, and old agents.

[8] Note that a fraction f of the medical expenditure is covered by the NHI.

[9] Note that the pure community rating prohibits premium discrimination based upon demographic characteristics including age. In Korea, however, the *adjusted* community rating is adopted and thus insurance premiums can vary across different age groups.

[10] As discussed shortly, q_y and q_o are calibrated so that the PHI take-up ratio for each generation can match the data for 2016 Korea.

the old are realized. The "able" young agents ($d'=0$) choose to work or not to work. At the end of the period, the agents receive wage or/and interest, pay net-out-of-pocket medical expense, and make a savings decision. It is noteworthy that the realization of idiosyncratic shocks and the agent's decision-making take place in two stages. In the first stage, the labor productivity shock z is realized, and each agent makes a choice on the purchase of PHI. In the second stage, the medical expense shocks m' or $\tilde{m}'$ and the disability condition shock d' are realized, and each young agent decides whether or not to work, which in turn determines its consumption, c, and savings, a'.

1. Recursive Formulation

Agents in each generation make decisions on the purchase of a PHI, the levels of consumption and savings, and their occupation to maximize their (discounted) lifetime expected utility.[11]

Young Agent

The young agent's optimization problem can be written as follows:

$$V_y(z, m, d, a)=\max_{i_{PHI}}\Bigg[\sum_{m'}\sum_{d'}P^y(m', d'|m, d)\max_{c,\, i_h,\, a'}\Big\{u(c, i_h\bar{h})$$
$$+\beta\{(1-\pi_o)\mathbb{E}[V_y(z', m', d', a')|z]+\pi_o V_o(\tilde{m}', a')\}\Big\}\Bigg] \tag{3}$$

subject to

$$(1+\tau_c)c+a'=D_y+T_y+i_{PHI}\{f_p(1-f)m'-q_y\}+\nu \tag{4}$$

$$D_y\equiv\begin{cases}\{1+(1-\tau_k)r\}(a+b)+i_h(1-\tau_h-\tau_N)wz\bar{h}-(1-i_h)p_N-(1-f)m' & \text{if } d'=0\\ \{1+(1-\tau_k)r\}(a+b)-p_N-(1-f)m' & \text{if } d'=1\end{cases}$$

$$T_y\equiv\max\{0, (1+\tau_c)\underline{y}-D_y\}$$

where i_{PHI} is an indicator variable for the agent's choice on the purchase of a PHI, taking 1 in case of purchasing it or 0 otherwise; and i_h is an indicator variable for the agent's working decision, taking 1 when it chooses to work or 0 otherwise.

In the beginning of each period, young agents calculate the expected benefit of the PHI, based on the last period's medical expense m and disability condition d and the transition probability distribution function P^Y, and decide whether or not to purchase it. As seen in (4), those who buy a PHI pay the PHI premium q_y and receive partial reimbursement from the insurance provider for the amount of medical expense they actually pay (excluding the amount covered by NHI), which amounts to $f_p(1-f)m'$.

After the realization of (m', d'), the "able" agents with $d'=0$ choose either to work or not to work, according to which the disposable income (net of the out-of-pocket medical expense and the NHI premium), D_y, is determined. Those who choose to work earn labor income, on

[11] The occupation choice is restricted to the young.

which the proportional labor income tax and the NHI premium are charged, as well as capital income. Those who choose not to work and those who are "disable" ($d'=1$) earn only capital income and pay the fixed amount of the NHI premium p_N. Agents whose disposable income is less than $\underline{y}$ receive the SI subsidy T_y.

The agents split the sum of the disposable income, the SI subsidy, the net reimbursement from the PHI, and the dividend from the PHI providers into consumption c and savings a' to maximize their lifetime expected utility.[12]

Old Agent

The old agent's optimization problem is given by:

$$V_o(\tilde{m}, a)=\max_{i_{PHI}}\left[\sum_{\tilde{m}'}P^o(\tilde{m}'\,|\,\tilde{m})\left\{\max_{c,\,a'}[u(c,\,0)]+\beta(1-\pi_q)V_o(\tilde{m}',\,a')\right\}\right] \tag{2}$$

subject to

$$(1+\tau_c)c+a'=D_o+T_o+i_{PHI}\{f_p(1-f)\tilde{m}'-q_o\}+\nu$$

$$D_o=\{1+(1-\tau_k)r\}(a+b)-p_N-(1-f)\tilde{m}'$$

$$T_o=\max\{0,\,(1+\tau_c)\underline{y}-D_o\}$$

The old agent's decision on the purchase of a PHI is made prior to the realization of the medical expense shock. Since old agents are not allowed to work by assumption, the optimization of the old is similar to that of the "disable" young agent with $d'=1$.

2. Steady State Equilibrium

Let s_y and s_o denote the sets of a young agent's state variables (z, m, d, a) and of an old agent's state variables $(\tilde{m}, a)$, respectively. The steady state equilibrium consists of (i) the young agent's value functions, $V_y(s_y)$, and policy functions, $i_{PHI}(s_y)$, $i_h(s_y)$, $c(s_y)$, and $a'(s_y)$, (ii) the old agent's value function, $V_o(s_o)$, and policy functions, $i_{PHI}(s_o)$, $c(s_o)$, and $a'(s_o)$, (iii) the representative firm's production decisions, $L^\star$ and $K^\star$, (iv) factor prices, $w^\star$ and $r^\star$, (v) a NHI premium rate for the employed $\tau_N^\star$, (vi) SI subsidy, T_y and T_o, (vii) government consumption, G, (viii) measures of the young and the old, $\Phi_y(s_y)$ and $\Phi_o(s_o)$, such that:

1. The policy functions of the young and the old solve the Bellman equations (1) and (2).
2. $L^\star$ and $K^\star$ maximizes the profit of the representative firm:

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

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

3. The factor markets clear:

[12] For simplicity, we assume that the dividend from the PHI providers is tax-free and it is not used in the process of determining who are entitled to receive the SI subsidy.

$$L^{\star}=\bar{h}\int zi_h(s_y)d\Phi_y$$

$$K^{\star}=\int ad\Phi_y+\int ad\Phi_o+b$$

4. The budget of NHI program is balanced:

$$\tau_N^{\star}w^{\star}L^{\star}+p_N\left\{\int\{1-i_h(s_y)\}d\Phi_y+\int 1d\Phi_o\right\}=f\left\{\int md\Phi_y+\int\tilde{m}d\Phi_o\right\}$$

where the LHS and RHS denote the revenue and expenditure of the NHI program, respectively.

5. The budget of SI program is balanced:

$$\tau_c\left\{\int c(s_y)d\Phi_y+\int c(s_o)d\Phi_o\right\}+\tau_k r^{\star}\left\{\int ad\Phi_y+\int ad\Phi_o+b\right\}+\tau_h w^{\star}L^{\star}=$$

$$G+\left\{\int T_y(s_y)d\Phi_y+\int T_o(s_o)d\Phi_o\right\}$$

where the LHS and the RHS denote the revenue and expenditure of the SI program, respectively.

6. The measures of the young and the old, $\{\Phi_y, \Phi_o\}$, are invariant over time.

Note that it is the endogenously determined NHI premium rate for the employed $\tau_N^{\star}$ that enables the budget of NHI program to be balanced and that with the tax rates, τ_c, τ_k, and τ_h exogenously given, the balanced budget for SI program is achieved through G.[13]

III. *Calibration*

We calibrate our model to the 2016 Korea's economy. One period in our model corresponds to one year. As mentioned earlier, the population is divided into two groups by agent's age: the young and the old. Those aged 15 to 64 (the working age population) and those aged 65+ are considered as the young agents and the old agents in the model, respectively. The probability of the young's becoming the old, π_o, is set to 1/49, so that the young agent's work-life expectancy becomes 49 years. The probability of the old's dying, $\pi_q=0.11$, is calibrated to match the 2016 Korea old-age dependency ratio, 18.4%, as reported in World Development Indicator by World Bank.

The risk aversion parameter, σ, is 1.0, a widely adopted value in the literature. The elasticity of labor supply, γ, is 0.4 as in Chang and Kim (2007). We assume that the stochastic process for agent's labor productivity z follows a first order auto-regressive process in logarithms: $\log z'=\rho_z\log z+\epsilon_z$ with $\epsilon_z \sim i.i.d.N(0, \sigma_z^2)$. Then, we take the values for $\rho_z(=0.79)$ and $\sigma_z(=0.35)$ from Lim (2016) and apply Tauchen (1986) to discretize the AR(1) process of z with ten grid points $(z_1, z_2, ..., z_9, z_{10})$. The parameter governing the employee's working hours, $\bar{h}$, is set to 0.398, which is the average working hour of Korean (Chang et al. (2015)). The

[13] Other than enabling the budget of SI program to be balanced, G has no other roles in the model.

TABLE 1. STATUS OF MEDICAL EXPENSE

Group		Avg. Med. Expense (₩)	Ratio to Young Bottom 60%
Able Young	Bottom 60%	47,480	1.0
	60-95%	621,396	13.1
	95-99%	3,013,186	63.5
	Top 1%	7,496,688	157.9
Disable Young	Bottom 60%	44,851	0.9
	60-95%	755,083	15.9
	95-99%	3,440,639	72.5
	Top 1%	9,472,508	199.5
Old	Bottom 60%	293,740	6.2
	60-95%	1,696,421	35.7
	95-99%	5,891,262	124.1
	Top 1%	14,400,000	303.3

labor income share, α, and the annual depreciation rate, δ, are set to 0.60 and 0.06, respectively. The labor income tax rate, τ_h, consumption tax rate, τ_c, and interest income tax rate, τ_k, are set to 0.20, 0.10, and 0.154, respectively, to accurately reflect the 2016 Korean tax rate system. The NHI coverage ratio, f, is set to 0.626, as reported by National Health Insurance Service of Korea in 2016. The PHI coverage ratio, f_P, is chosen at 0.854.[14]

Following Hsu (2013), the medical expense shock of the old is discredited by four grid points: $\{\tilde{m}_1, \tilde{m}_2, \tilde{m}_3, \tilde{m}_4\}$ where a grid point subscripted by a bigger number represents a higher level of medical expense. In particular, for each generation, the 1st, 2nd, 3rd, and 4th grid point represent the average medical expense of the bottom 60%, from 60 to 95%, from 95 to 99%, and top 1%, respectively. Based on the 2015 Korean Health Panel, each group's average medical expense among those who are aged 65+ are calculated at 293,740, 1,696,421, 5,891, 262, and 14,400,000 won, respectively.[15]

The young agents are further divided into two groups: the "able" young and the "disable" young.[16] The disable young refer to agents belonging to the working age population who are not working due to illness or health-related issues, and the able young the remaining agents of the working age population. Similar to the old, the medical expense shock of each group of the young is discretized by four grid points: $\{m^A_1, m^A_2, m^A_3, m^A_4\}$ for the able young and $\{m^D_1, m^D_2, m^D_3, m^D_4\}$ for the disable young, each grid point representing the average medical expense of the bottom 60%, from 60 to 95%, from 95 to 99%, or top 1% in the relevant population group. Table 1 summarizes the average medical expense of each group. Importantly, it reveals the medical expense of the disable young is significantly higher than that of the able

[14] In general, the types of medical expenses can be divided into two, depending on whether the medical expenses are controlled by the government policy to pursue the public interest. In Korea, the medical expenses controlled by the government usually lies in the coverage of the NHI, and they are co-paid by patients and the NHI. The PHI covers the out-of-pocket medical expense lying in this category (the co-payment) and the medical expenses not controlled by government in the first place, with 10 and 20% of deductible applied, respectively.

[15] Won (₩) is a currency unit in Korea.

[16] The survey of the 2015 Korean Health Panel allows us to divide the young into two groups. Lim (2016) says, "... *the Korean Health Panel has information on the working status of every respondent and a specific reason for every non-working respondent. More importantly, one of the listed reasons for not working in the survey is illness or health-related issues ...*".

TABLE 2. JOINT TRANSITION MATRIX FOR MEDICAL EXPENSE AND DISABILITY CONDITION: THE YOUNG

State		Next Period							
		$(m_1^A, 0)$	$(m_1^D, 1)$	$(m_2^A, 0)$	$(m_2^D, 1)$	$(m_3^A, 0)$	$(m_3^D, 1)$	$(m_4^A, 0)$	$(m_4^D, 1)$
Current State	$(m_1^A, 0)$	77.3	0.3	19.9	0.1	1.8	0.0	0.5	0.0
	$(m_1^D, 1)$	50.8	28.6	6.3	11.1	1.6	1.6	0.0	0.0
	$(m_2^A, 0)$	35.0	0.1	57.0	0.9	5.7	0.1	1.0	0.1
	$(m_2^D, 1)$	10.3	9.2	36.8	26.4	9.2	5.7	1.1	1.1
	$(m_3^A, 0)$	25.4	0.4	52.0	1.9	15.1	1.0	4.0	0.2
	$(m_3^D, 1)$	0.0	11.5	34.6	15.4	26.9	3.8	3.8	3.8
	$(m_4^A, 0)$	19.0	0.0	49.2	4.8	11.9	4.0	8.7	2.4
	$(m_4^D, 1)$	0.0	0.0	0.0	38.5	15.4	0.0	15.4	30.8

Note: Each cell in the matrix represents the probability of transitioning from the current state to the next period's state, where the second element of each pair denotes the disability condition; Units are in percent.

TABLE 3. TRANSITION MATRIX FOR MEDICAL EXPENSE: THE OLD

%	$\tilde{m}_1$	$\tilde{m}_2$	$\tilde{m}_3$	$\tilde{m}_4$
$\tilde{m}_1$	74.8	22.5	2.1	0.6
$\tilde{m}_2$	39.1	53.7	6.0	1.2
$\tilde{m}_3$	31.1	55.3	11.8	1.9
$\tilde{m}_4$	19.5	48.8	14.6	17.1

Note: Each cell in the matrix represents the probability of transitioning from the current state to the next period's state; Units are in percent.

young except in the bottom 60%. Table 1 also reports the ratios of the average medical expense of the population sub-group to that of the bottom 60% of the able young. With these ratios fixed, we set $m_1^A=0.005$ so that aggregate medical expense in our model amounts to 7.3% of aggregate output, which is consistent with the ratio of current expenditure on health to GDP for 2016 Korea as reported in OECD Health Statistics 2018. Given the grids for the medical expense shocks of the young and the old, we estimate the joint transition probability matrix for medical expense and disability condition shocks for the young and the transition probability matrix for medical expense for the old based on the 2015-16 Korean Health Panel (See Table 2-3).

The discount factor, β, is set at 0.96 so that the annual interest rate becomes 4 percent. The disutility from working, B, is chosen at 83.2 so that the employment ratio of the model matches that of Korea in 2016, 66.1 percent. The minimum cost of living guaranteed by the SI program, $\underline{y}=0.002$, is calibrated so that the percentage of the SI recipients is 3.2 percent as in Korea in 2016.[17] The fixed (not proportional to income) NHI premium for non-workers, p_N, are chosen at 0.013 so that the non-worker's share of the aggregate NHI premium becomes 16.1%, as reported by National Health Insurance Service of Korea in 2016. The PHI premiums for the young and the old, q_y and q_o, are set to 0.009 and 0.053, respectively, so that the percentages of the young PHI holders and the old PHI holders match the percentages of the aged 20-59 and 60+ with the PHI in data, 76.6% and 29.3%, respectively.[18]

[17] The source is a document by the Ministry of Health and Welfare of Korea.

[18] Korea Credit Information Services (2016) reports the percentages of individuals who own the PHI by seven

TABLE 4. CALIBRATED PARAMETERS

Parameter	Description	Source (or Target Moment)
	Non-targeted parameters	
$\pi_o=1/49$	Probability of being aged	Work-life expectancy, 49 years
$\pi_q=0.11$	Probability of dying	Old-age dependency ratio, 18.4%
$\sigma=1.0$	Risk-aversion parameter	Literature
$\gamma=0.4$	Labor supply elasticity	Chang and Kim (2007)
$\rho_z=0.79$	$\log z'=\rho_z \log z+\epsilon_z$	Lim (2016)
$\sigma_z=0.35$	where $\epsilon_z \sim N(0, \sigma_z^2)$	Lim (2016)
$\bar{h}=0.40$	Working hours	Chang et al. (2015)
$\alpha=0.60$	Labor income share	Literature
$\delta=0.06$	Depreciation rate	Literature
$\tau_h=20.0\%$	Labor income tax rate	Lim (2016)
$\tau_c=10.0\%$	Consumption tax rate	2016 Korea; value-added tax rate
$\tau_k=15.4\%$	Interest income tax rate	2016 Korea
$f=62.6\%$	NHI coverage ratio	2016 Korea
$f_p=85.4\%$	PHI coverage ratio	2016 Korea
Parameter	Description	Source (or Target Moment)
	Targeted parameters	
$m_1^A=0.005$	Explained in main text	Current exp. on health to GDP, 7.3%
$\beta=0.96$	Discount factor	Annual interest rate, 4.0%
$B=83.2$	Disutility from working	Employment ratio, 66.1%
$\underline{y}=0.002$	Minimum cost of living	Percentage of SI recipients, 3.2%
$p_N=0.013$	Non-workers' NHI prem.	Non-workers' share of NHI prem., 16.1%
$q_y=0.009$	PHI prem. for young	% of aged 20-59 with the PHI, 76.6%
$q_o=0.053$	PHI prem. for old	% of aged 60+with the PHI, 29.3%

Note: Target moments are values for 2016 Korea unless stated otherwise.

All calibrated parameters are summarized in Table 4.

IV. *Quantitative Analysis*

In this section, we start with an examination of the determinants of PHI purchase decision—who purchases a PHI—and then discuss about why the incorporation of the PHI is crucial to the analysis of the impacts of the NHI coverage expansion. Finally, we investigate the macroeconomic impacts and welfare implications of the NHI coverage expansion by comparing the model economies with different NHI coverage ratios.

1. Determinants of PHI Purchase Decision

To analyze how individual characteristics affect the purchase of a PHI, we draw a sample of one million agents from the invariant distributions of the young and the old, Φ_y and Φ_o, of the calibrated model economy. Using the sample, we perform a probit analysis, where a dependent variable is i_{PHI} and explanatory variables are the state variables, namely, (z, m, d, a)

different age groups, 10-19, 20-29, 30-39, 40-49, 50-59, 60-69, and 70+, based upon the big data analysis. The percentages of the aged 20-59 and 60+ with the PHI are calculated based on the report.

TABLE 5. DETERMINANTS OF PHI PURCHASE DECISION

i_{PHI}	(1) Old	(2) Young
a	.072	-.041
m or $\tilde{m}$	4.656	17.690
d	-	.086
z	-	-.050

Note: (i) The dependent variable is i_{PHI}; (ii) The explanatory variables are ($\tilde{m}$, a) for the old and (z, m, d, a) for the young; and (iii) All the estimated coefficients are highly, statistically significant (the standard errors are omitted).

for the young and ($\tilde{m}$, a) for the old. The probit regressions are conducted separately for the young and the old to capture the (potential) difference in the determinants of the PHI purchase across age groups.

Table 5 summarizes the probit regression results. The probit regression based on the sample of the old reveals that old agents are more likely to purchase a PHI when they are richer and their medical expenses are higher (See Column (1) of Table 5); an old agent with a higher level of medical expense are more eager to buy a PHI if she can afford it. This pattern, however, is not observed in the result of the probit regression based on the sample of the young: Column (2) indicates that while a higher medical expense as well as the disability induces a higher likelihood for the young to purchase a PHI, a greater amount of financial assets or a higher level of labor productivity results in a lower likelihood. The negative impact of financial assets on the young agent's purchase of a PHI derives from the fact that financial assets can be utilized to insure against the medial expense shock; the asset-rich agents can effectively smooth consumption by disaccumulating their assets, without resorting to PHI. In addition, a higher labor productivity means a potentially greater labor income to a young agent, and thus it is predicted that one's desire to buy a PHI decreases with the level of labor productivity.

2. Aggregate Implications of PHI

In this subsection, we investigate how the availability of the PHI to agents affect macroeconomic variables and welfare in the benchmark economy. To do so, we come up with another benchmark economy (denoted by Benchmark 2) that is different from the *originally* calibrated model economy (denoted by Benchmark 1) only in that the PHI is not available to any agents in Benchmark 2. Table 6 (a) compares macroeconomic variables of the two economies. It indicates that whether or not to incorporate the PHI into the model has little impact on macroeconomic variables. It is a straightforward result given that (i) the PHI is a secondary insurance coming after the NHI and (ii) there is the SI that guarantees the minimum cost of living in both Benchmark 1 and 2. On the contrary, the availability of the PHI to agents affects their welfare levels in a meaningful manner. Table 6 (b) compares the welfare levels of the young and the old as well as the welfare levels of the sub-groups in each generation by asset holdings (the asset-rich; the top 50% vs. the asset-poor; the bottom 50%). It suggests that without the PHI the model systematically overstates the welfare level of the old and understates the welfare of the young. Thus, it can be said that incorporating the PHI into the model can help to compare the welfares of different age groups more accurately by correcting this issue.

Table 6. Aggregate Implications of PHI: Benchmark 1 vs Benchmark 2

(a) Macroeconomic Variables

	Y	L	K	w	r	Empl.	PHI-Y	PHI-O	τ_{NHI}
BM 1	0.808	0.321	3.235	1.513	0.04	66.11%	76.56%	29.31%	6.39%
BM 2	0.809	0.321	3.239	1.513	0.04	66.24%	-	-	6.39%

(b) Welfare

Age	All		Poor		Rich	
	BM 1	BM 2	BM 1	BM 2	BM 1	BM 2
Young	-28.69	-28.71	-34.23	-34.25	-23.18	-23.19
Old	-23.92	-23.69	-33.86	-33.51	-14.05	-13.90

Note: BM 1 and 2 denote the benchmark economies with and without the PHI, respectively, and "PHI-Y" and "PHI-O" denote the PHI take-up ratios for the young and the old, respectively.

Table 7. Macroeconomic Variables: Economies with Different NHI Coverage Ratios

f	Y	L	K	w	r	Empl.	PHI-Y	PHI-O	τ_{NHI}
62.6%	0.808	0.321	3.235	1.513	0.040	66.11%	76.56%	29.31%	6.39%
70.0%	0.802	0.319	3.194	1.507	0.040	65.70%	39.58%	3.82%	7.33%
80.0%	0.792	0.317	3.128	1.499	0.041	65.08%	39.23%	0.78%	8.65%
90.0%	0.782	0.315	3.054	1.488	0.042	64.41%	5.74%	0.00%	10.01%

Note: "Empl." denotes the employment ratio, and "PHI-Y" and "PHI-O" denote the PHI take-up ratios for the young and the old, respectively.

3. Experiment: NHI Coverage Expansion

In this subsection, we investigate the macroeconomic impacts and welfare implications of the NHI coverage expansion by comparing the model economies with different NHI coverage ratios. We recalculate the steady state equilibria of the model economies that differ from our benchmark economy—the calibrated model economy in section 3—only in the NHI coverage ratio f : f=70, 80, and 90%. We assume that the PHI providers charge the same levels of premiums regardless of the NHI coverage expansion.[19]

Table 7 summarizes how key macroeconomic variables are changed with expansion of the NHI coverage. When the NHI coverage ratio, f, is increased, the NHI premium rate for the employed, τ_{NHI}, should be increased to balance the increased NHI budget. The decrease in the after-NHI-premium wage reduces the young agent's incentive to work and so aggregate labor, L, and the employment rate decrease.

It is worth noting that agents are exposed to two types of uncertainties: one that originates from labor productivity (or income) shock and one that originates from medical expense shock. To insure against these shocks, they can accumulate financial assets or/and purchase a PHI. The expansion of the NHI coverage reduces the uncertainty from medical expense shock, which

[19] In Appendix, we provide results from an alternative model experiment where the PHI providers are allowed to adjust the levels of premiums to reflect the decreases in their costs.

TABLE 8. PHI TAKE-UP RATE AND ASSET HOLDINGS

(a) All Agents

Statics	Group	Benchmark	f=70%	f=80%	f=90%
Asset Holdings	All	3.230	3.189 (-1.3%)	3.124 (-3.3%)	3.049 (-5.6%)
	- Rich	5.328	5.254 (-1.4%)	5.152 (-3.3%)	5.040 (-5.4%)
	- Poor	1.128	1.120 (-0.7%)	1.091 (-3.3%)	1.057 (-6.2%)
PHI Take-up Ratio	All	69.2%	34.0% (-50.8%)	33.3% (-52.0%)	4.9% (-93.0%)
	- Rich	68.6%	37.2% (-45.7%)	36.8% (-46.4%)	5.2% (-92.4%)
	- Poor	69.9%	30.8% (-55.9%)	29.7% (-57.5%)	4.5% (-93.5%)

(b) The Young

Statics	Group	Benchmark	f=70%	f=80%	f=90%
Asset Holdings	All	3.481	3.437 (-1.3%)	3.366 (-3.3%)	3.285 (-5.6%)
	- Rich	5.619	5.544 (-1.3%)	5.446 (-3.1%)	5.332 (-5.1%)
	- Poor	1.334	1.320 (-1.0%)	1.283 (-3.8%)	1.239 (-7.2%)
PHI Take-up Ratio	All	76.6%	39.6% (-48.3%)	39.2% (-48.8%)	5.7% (-92.5%)
	- Rich	71.5%	39.4% (-44.8%)	39.8% (-44.4%)	5.7% (-92.1%)
	- Poor	81.7%	39.7% (-51.4%)	38.7% (-52.6%)	5.8% (-92.9%)

(c) The Old

Statics	Group	Benchmark	f=70%	f=80%	f=90%
Asset Holdings	All	1.865	1.846 (-1.0%)	1.807 (-3.17%)	1.767 (-5.3%)
	- Rich	3.339	3.294 (-1.3%)	3.211 (-3.87%)	3.110 (-6.9%)
	- Poor	0.383	0.398 (4.0%)	0.403 (5.37%)	0.422 (10.4%)
PHI Take-up Ratio	All	29.3%	3.8% (-87.0%)	0.8% (-97.3%)	0.0% (-100%)
	- Rich	34.8%	4.5% (-87.0%)	0.9% (-97.4%)	0.0% (-100%)
	- Poor	23.7%	3.1% (-86.9%)	0.7% (-97.2%)	0.0% (-100%)

Note: Numbers in parentheses refer to the percentage change from the benchmark; and (ii) "Rich" ("Poor") refers to those in top (bottom) 50% asset group.

leads to decreases in both the PHI take-up ratio and aggregate capital, as confirmed in Table 7.[20] Since both production factors—L and K—decrease in response to the expansion of NHI coverage, aggregate output drops. In addition, the disproportionately large declines in aggregate capital result in higher rates of return for capital, as opposed to relatively small decreases in wage.

Next, we investigate the impacts of the expansion of the NHI coverage on the PHI take-up ratio and asset holdings, with extra attention to the differential impacts across different age and asset groups. A first thing to note is that while Table 8 (a) demonstrates that the coverage expansion of the NHI leads to a decrease in asset holdings of the whole population, different patterns are observed for the young and the old: Table 8 (b) shows that young agents, regardless of the asset group (the asset-rich; the top 50% vs. the asset-poor; the bottom 50%), tend to reduce asset holdings as the NHI coverage expands. For the old, on the contrary, Table 8 (c) informs that this pattern is observed only for the asset-rich group; the asset holdings of old poor agents increase with the coverage rate of the NHI. To see why this is the case, it is

[20] The plummet in the PHI take-up ratio is mainly because of our assumption of the unvarying PHI premiums. In Appendix, we conduct an alternative model experiment where the PHI providers change the premiums proportionally to the cost incurred.

Table 9. Labor Share, Employment Rate, and PHI Take-up Rate by Labor Productivity

(a) Employment Rate

Labor Prod.	Benchmark	f=70%	f=80%	f=90%
High	88.6%	88.3% (-0.3%p)	87.8% (-0.8%p)	87.3% (-1.3%p)
Low	43.7%	43.1% (-0.5%p)	42.3% (-1.3%p)	41.6% (-2.1%p)

(b) Labor Share

Labor Prod.	Benchmark	f=70%	f=80%	f=90%
High	83.8%	84.0% (0.1%p)	84.2% (0.3%p)	84.3% (0.5%p)
Low	16.2%	16.0% (-0.1%p)	15.8% (-0.3%p)	15.7% (-0.5%p)

(c) PHI Take-up Rate

Labor Prod.	Benchmark	f=70%	f=80%	f=90%
High	74.5%	39.3% (-35.3%p)	39.3% (-35.3%p)	5.8% (-68.8%p)
Low	78.6%	39.9% (-38.7%p)	39.2% (-39.4%p)	5.7% (-72.9%p)

Note: "High" and "Low" denote the groups of high labor productivity (z_6-z_{10}) and low labor productivity (z_1-z_5).

essential to understand the reason for the low asset holdings of the old poor in the benchmark economy. Given that old agents have no labor income and are burdened with high medical expenses, the low coverage of the NHI in the benchmark economy may bring down the disposable income—after paying the out-of-pocket medical expense—of some old agents with low level of assets to the level of minimum income to be eligible for the SI, leaving them with no incentive to save. As the coverage of the NHI expands, however, their disposable income gets increased to the level in which they would be better off making savings than receiving allowance from the SI or they would be left with no choice but making savings because the SI is no longer eligible. As a result, the asset holdings of the old poor group increase in the coverage rate of the NHI.

Before jumping into the discussion about changes in the PHI take-up ratio in response to the coverage expansion of the NHI, it is worth noting that there is a difference in the observed patterns of the PHI take-up ratio between the young and the old in the benchmark economy: for the young, the asset-rich group shows a lower ratio of the PHI take-up than the asset-poor group (71.5% vs. 81.7%); for the old, on the contrary, the asset-rich group shows a higher ratio of the PHI take-up than the asset-poor group (34.8% vs. 23.7%). Intuitively, as agents with higher level of assets are more likely to be able to self-insure against the medical expense shocks, one can expect that the asset rich group shows a lower ratio of the PHI take-up than the asset poor group. In our model, however, the old are retirees with the interest as a single income source. As such, when they are poor enough to be eligible for the SI, they might be better off resorting to allowance from the SI rather than purchasing a PHI, which leads to a lower ratio of the PHI take-up for the asset poor group. Finally, as expected, Table 8 (a) shows that the PHI take-up ratio of the whole population decreases with the expansion of the NHI coverage. It is immediate from comparison of Table 8 (b) and (c) that the old cuts back the purchase of a PHI more heavily than the young. But this might be a direct result of different margins of the PHI for the young and the old.

Table 9 summarizes how the changes in labor share, employment rate, and PHI take-up

TABLE 10. WELFARE

Group	Wealth	Benchmark	f=70%	f=80%	f=90%
All	All	-27.95	-27.87 (0.31%)	-27.74 (0.75%)	-27.57 (1.36%)
	Rich	-22.57	-22.58 (-0.05%)	-22.61 (-0.15%)	-22.55 (0.09%)
	Poor	-33.34	-33.16 (0.55%)	-32.89 (1.36%)	-32.59 (2.25%)
Young	Rich	-23.18	-23.21 (-0.11%)	-23.21 (-0.10%)	-23.23 (-0.21%)
	Poor	-34.23	-34.18 (0.14%)	-34.15 (0.23%)	-34.12 (0.33%)
Old	Rich	-14.05	-13.71 (2.38%)	-13.28 (5.50%)	-12.87 (8.37%)
	Poor	-33.86	-33.12 (2.16%)	-32.10 (5.19%)	-30.30 (10.50%)

Note: (i) Numbers in parentheses refer to the percentage change from the benchmark; for each group it is calculated as: (welfare of the experimental economy - welfare of the benchmark economy)/|welfare of the benchmark economy|; and (ii) "Rich" ("Poor") refers to those in top (bottom) 50% asset group.

ratio in response to the expansion of the NHI coverage are different depending on the level of labor productivity. Young agents are divided into two groups based on the level of labor productivity. Those with z_1-z_5 and those with z_6-z_{10} are categorized into low productivity group and high productivity group, respectively. According to Table 9 (a), the employment rates of both groups decrease monotonically with the expansion of NHI coverage, but the employment rate of the high labor productivity group decreases less. As such, the labor share of the high labor productivity group increases with the increase in the NHI coverage rate (Table 9 (b)), which partially offsets the production loss from the NHI premium burden. Finally, Table 9 (c) shows that the low labor productivity group reduces the purchase of PHI more than the high labor productivity group in response to the expansion of NHI coverage.

Table 10 demonstrates how the expansion of NHI coverage affects welfare of the economy. It contrasts different welfare impacts on different age and asset groups, which can be summarized as follows. First, the top section of the table compares changes in welfare of the asset-rich and the asset-poor for all population. It can be confirmed that the welfare of the asset-poor agents increases more than that of the asset-rich when the NHI coverage ratio is increased, which points out the welfare redistribution effect of the NHI coverage expansion policy. Second, comparison between the second and the third sections reveals that the old benefits more than the young, in terms of welfare, which is intuitive given their higher level of medical expense and yet constant level of contribution to the NHI budget. Hence, it can be said that the NHI coverage expansion redistributes welfare toward the old and the poor.

Finally, it should be stressed that there is a caveat to the interpretation of the experiment results. When we conduct the model experiments, we assume that the shock process of medical expense is invariant. In the real world, however, it cannot be excluded that thanks to the NHI coverage expansion, the household's increased disposable income might channel into consumption of health care and medical care, which might lead to an increase in the medical expense. If so, the quantitative effects of the NHI coverage expansion on the PHI take-up ratio, labor supply, and savings must be overestimated to the extent to which the distribution of medical expense is shifted to the right.

V. *Conclusion*

We investigate the macroeconomic impacts of coverage expansion of universal health care (UHC), which has drawn little attention in the literature. We construct a dynamic general equilibrium model with heterogeneous agents, an endogenous labor supply, and an endogenous demand for PHI. We calibrate the model to Korea—a country with an established UHC system and a private health insurance (PHI) market—and perform a quantitative exercise in which the UHC coverage ratio is exogenously increased to 70, 80, and 90%.

When the UHC coverage ratio is increased, the UHC insurance premium is increased given the budget balance condition for UHC, which in turn leads to a decrease in aggregate labor and the employment rate. Moreover, the uncertainty from medical expense shock is reduced with the expanded coverage of UHC, and thus aggregate capital and the PHI take-up ratio decrease. While aggregate output shrinks (as both production factors decrease), it turns out that welfare increases monotonically in the coverage ratio of UHC. Moreover, our analysis suggests that the UHC coverage expansion has welfare redistribution impact toward the old and the poor.

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A Alternative Model Experiments

In the model experiment discussed in the main body, we assume that the PHI premiums are unchanged with the NHI coverage expansion. Given that the PHI covers the out-of-pocket medical expense after the NHI reimbursement, the total cost from the perspective of PHI providers would be decreased, enabling them to lower the premiums. To take it into account, we conduct alternative model experiments. Specifically, suppose that in the benchmark economy the PHI providers set the premiums for the young and old as follows:

$$q_y = \mathcal{M}_y \left\{ f_p (1-f) \int m \, d\Phi_y \right\}$$

$$q_o = \mathcal{M}_o \left\{ f_p (1-f) \int \tilde{m} \, d\Phi_o \right\},$$

where $\mathcal{M}_y$ and $\mathcal{M}_o$ denote the profit margins of the PHI for the young and the old, respectively.

Given the pricing method above, we can extract the values of profit margins for the young and the old. In this section, we assume that the profit margins are constant regardless of the NHI coverage ratio; it is worth noting that the terms inside the braces would decrease when the NHI coverage is expanded, which results in lower premiums. We perform model experiments where everything is the same as in the original model experiments except the varying levels of premiums. The results are summarized in Table 11-14. Compared to the results with the other pricing mechanism of premiums summarized in Table 7-10, everything but the responses of the PHI take-up ratios is the same; it turns out that the PHI take-up ratios do not decrease monotonically in the coverage rate of the NHI.

Table 11. Macroeconomic Variables: Economies with Different NHI Coverage Ratios

f	Y	L	K	w	r	Empl.	PHI-Y	PHI-O	τ_{NHI}
62.6%	0.808	0.321	3.235	1.513	0.040	66.11%	76.56%	29.31%	6.39%
70.0%	0.802	0.319	3.192	1.507	0.040	65.70%	75.21%	28.93%	7.34%
80.0%	0.793	0.317	3.132	1.499	0.041	65.12%	73.38%	27.01%	8.65%
90.0%	0.782	0.315	3.055	1.489	0.042	64.36%	75.36%	23.14%	10.01%

Note: "Empl." denotes the employment ratio, and "PHI-Y" and "PHI-O" denote the PHI take-up ratios for the young and the old, respectively.

Table 12. PHI Take-up Rate and Asset Holdings

(a) All Agents

Statics	Group	Benchmark	f=70%	f=80%	f=90%
Asset Holdings	All	3.230	3.188 (-1.3%)	3.128 (-3.3%)	3.051 (-5.6%)
	- Rich	5.328	5.254 (-1.4%)	5.156 (-3.3%)	5.040 (-5.4%)
	- Poor	1.128	1.119 (-0.7%)	1.091 (-3.3%)	1.056 (-6.2%)
PHI Take-up Ratio	All	69.2%	68.0% (-1.7%)	66.2% (-4.4%)	67.2% (-2.9%)
	- Rich	68.6%	66.2% (-3.4%)	64.0% (-6.6%)	66.7% (-2.7%)
	- Poor	69.9%	69.8% (-0.1%)	68.3% (-2.2%)	67.8% (-3.0%)

(b) The Young

Statics	Group	Benchmark	f=70%	f=80%	f=90%
Asset Holdings	All	3.481	3.435 (-1.3%)	3.371 (-3.3%)	3.287 (-5.6%)
	- Rich	5.619	5.543 (-1.3%)	5.443 (-3.1%)	5.334 (-5.1%)
	- Poor	1.334	1.320 (-1.0%)	1.283 (-3.8%)	1.239 (-7.2%)
PHI Take-up Ratio	All	76.6%	75.2% (-1.8%)	73.4% (-4.2%)	75.4% (-1.6%)
	- Rich	71.5%	68.9% (-3.6%)	67.7% (-5.3%)	71.4% (-0.1%)
	- Poor	81.7%	81.5% (-0.2%)	79.1% (-3.2%)	79.3% (-2.9%)

(c) The Old

Statics	Group	Benchmark	f=70%	f=80%	f=90%
Asset Holdings	All	1.865	1.844 (-1.0%)	1.808 (-3.1%)	1.767 (-5.3%)
	- Rich	3.339	3.273 (-1.3%)	3.193 (-3.8%)	3.100 (-6.9%)
	- Poor	0.383	0.387 (4.0%)	0.395 (5.3%)	0.414 (10.4%)
PHI Take-up Ratio	All	29.3%	28.9% (-1.3%)	27.0% (-7.9%)	23.1% (-21.1%)
	- Rich	34.8%	32.1% (-7.9%)	26.0% (-25.3%)	17.5% (-49.8%)
	- Poor	23.7%	25.7% (8.2%)	28.0% (18.0%)	28.9% (21.5%)

Note: Numbers in parentheses refer to the percentage change from the benchmark; and (ii) "Rich" ("poor") refers to those in top (bottom) 50% asset group.

Table 13. Labor Share, Employment Rate, and PHI Take-up Rate by Labor Productivity

(a) Employment Rate

Labor Prod.	Benchmark	f=70%	f=80%	f=90%
High	88.6%	88.3% (-0.3%p)	87.8% (-0.7%p)	87.2% (-1.4%p)
Low	43.7%	43.2% (-0.5%p)	42.4% (-1.2%p)	41.5% (-2.2%p)

(b) Labor Share

Labor Prod.	Benchmark	f=70%	f=80%	f=90%
High	83.8%	84.0% (0.1%p)	84.1% (0.3%p)	84.4% (0.5%p)
Low	16.2%	16.0% (-0.1%p)	15.9% (-0.3%p)	15.7% (0.5%p)

(c) PHI Take-up Rate

Labor Prod.	Benchmark	f=70%	f=80%	f=90%
High	74.5%	73.1% (-1.4%p)	71.8% (-2.7%p)	74.1% (-0.4%p)
Low	78.6%	77.3% (-1.3%p)	74.9% (-3.6%p)	76.6% (-2.0%p)

Note: "High" and "Low" denote the groups of high labor productivity (z_6-z_{10}) and low labor productivity (z_1-z_5).

Table 14. Welfare

Group	Wealth	Benchmark	f=70%	f=80%	f=90%
All	All	-27.95	-27.86 (0.34%)	-27.73 (0.78%)	-27.59 (1.31%)
	Rich	-22.57	-22.57 (0.00%)	-22.60 (-0.12%)	-22.56 (0.06%)
	Poor	-33.34	-33.15 (0.59%)	-32.89 (1.36%)	-32.63 (2.15%)
Young	Rich	-23.18	-23.20 (-0.08%)	-23.22 (-0.16%)	-23.23 (-0.20%)
	Poor	-34.23	-34.17 (0.18%)	-34.14 (0.25%)	-34.12 (0.32%)
Old	Rich	-14.05	-13.77 (1.99%)	-13.36 (4.87%)	-12.95 (7.81%)
	Poor	-33.86	-33.26 (1.76%)	-32.22 (4.82%)	-30.54 (9.79%)

Note: (i) Numbers in parentheses refer to the percentage change from the benchmark; for each group it is calculated as: (welfare of the experimental economy - welfare of the benchmark economy)/|welfare of the benchmark economy|; and (ii) "Rich" ("Poor") refers to those in top (bottom) 50% asset group.