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MACROECONOMIC EFFECTS OF EXPANSION OF UNIVERSAL HEALTH CARE: THE CASE OF SOUTH KOREA*

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Abstract

Using a general equilibrium model, we analyze the implications of Universal Health Care (UHC) expansion in Korea. We find that when UHC is expanded, UHC premium rate for workers is raised to finance the increased budget, which distorts the households' incentive to work and leads to a decrease in aggregate labor. Moreover, the reduced volatility of disposable income weakens the households' savings motive, thereby resulting in a decrease in aggregate capital. While the decreases in production factors lead to a significant drop in aggregate output, the binary voting simulation shows that the expansion of UHC is approved with near-unanimous support.

Keywords: Universal Health Coverage, National Health Insurance
JEL Classification Codes: E69, H51, I13, J21

I. *Introduction*

Korea achieved universal health care (UHC) as long ago as 1986 through a compulsory public health insurance referred to as National Health Insurance (NHI) since the first health insurance law was brought into force in 1963.[1] Due to its rapidity, Korea is often cited as one of most successful cases for the achievement of UHC. However, the low contribution and limited benefit coverage strategy, adopted at the time of implementing UHC, came at the cost of a high level of out-of-pocket (OOP) medical payments. OOP payments in 2012 accounted for 36% of total medical expenditure in Korea, compared with an average of 21% in the OECD (Lee (2015)).

A high level of OOP payments limits the function of UHC in financial protection, not to mention that it keeps households from getting appropriate medical treatments in a timely

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[1] UHC is defined as a health care system in which all citizens in a country can get health treatment they need without suffering financial hardship (World Health Organization (2010)).

manner. According to Xu et al. (2003) and Korea Institute for Health and Social Affairs (2013), the fraction of households with catastrophic health expenditure in 2007 was 2.8%,[2] which was 3 and 40 times higher than the US and UK, respectively. In step with recent growing global interest in UHC, the Korean government pronounced a goal to expand UHC in 2015.[3]

In this paper, we attempt to quantify the macroeconomic impacts of the UHC expansion and study whether it can be supported by majority rule. Our analyses, based on a heterogeneous-agents model, show that when the government increases the UHC coverage rate, almost all households support the expansion of UHC even though the policy incurs decreases in production factors and thus in aggregate output.

In recent years, there has been growing interest among public health policymakers in UHC, and achieving UHC has become a top priority in many countries. In 2015, United Nations member states reached a global consensus on putting their best efforts into achieving UHC by 2030, which was included as one of the 17 Sustainable Development Goals of the 2030 Agenda for Sustainable Development.

The underlying reasons for supporting UHC are mainly twofold. First, medical expenses are considered one of main threats to households' welfare. It is often the case that high medical expenses induce high rates of unmet medical needs, delayed medical treatments, and even the deterioration of household solvency.[4] Second, public health policymakers, especially in poor countries, believe that achieving UHC can help promote economic growth. This belief is based on previous research documenting the positive effect of good health on economic outcomes, notably economic growth.[5]

Despite the promise of UHC, it is often the case that a significant fraction of households in countries with UHC still suffer from high medical expenses due to low coverage rates. Nonetheless, it is not an easy task to come to agreement on the expansion of UHC. Those in favor of UHC coverage expansion cite that an increase in the coverage rate can enhance household welfare by decreasing OOP medical expenses, thus increasing general goods consumption, as well as by reducing the disutility caused by fluctuations in future medical expenses. Those opposed are concerned that it distorts households' incentive to work and save, thereby bringing about economic inefficiency. They argue that households are less likely to work given that the required expense for the UHC coverage expansion is financed by an increase in mandatory payroll contributions.[6] They also claim that the reduced volatility of disposable income (net of OOP medical payments) reduces the household's (precautionary) savings motive.

The arguments from both sides are based on sound reasoning, yet a big remaining question

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[2] In the literature, catastrophic health expenditure is defined as OOP payments for health care that exceeds a certain proportion, usually 40 percent, of a household's income (see, for example, Xu et al. (2003)).

[3] In 2015, the Korean government pronounced a goal to expand the NHI coverage rate from 63.2 percent in 2014 to 68 percent by 2020 and to 70 percent by 2025.

[4] Domowitz and Sartain (1999) and Himmelstein et al. (2009) claim that high medical bills are one of the leading contributors to consumer bankruptcy in U.S. Gross and Notowidigdo (2011) also point out that high out-of-pocket medical expenses have even more damaging impacts on low-income households.

[5] Based on analysis of the micro-level data, Strauss and Thomas (1998) claim the existence of the causal impact of health on labor productivity, which has been corroborated by a substantial body of macro-evidence (Bloom and Canning (2003), Bloom et al. (2004), and Bhargava et al. (2001)).

[6] In 2015, 83.4% of the NHI revenue premiums in Korea came from worker contributions, which were levied in the form of a fixed percentage (6.47%) of payroll.

is which factor is more relevant and quantitatively dominant in the case of South Korea. In this paper, we attempt to answer this question by quantifying the macroeconomic impacts of the NHI coverage expansion and taking individual household voting decisions into consideration. In particular, we adopt a version of a heterogeneous-agents model with incomplete financial markets, suggested by Lim (2016), which is characterized by (i) idiosyncratic shock processes for households' labor productivity, medical expenses, and disability condition,[7] (ii) household's indivisible labor choice, and (iii) NHI that covers a fixed fraction of the medical expense of the entire population and is financed by the premiums levied on both workers and non-workers.

We calibrate the model to match salient features of the 2015 Korean economy. Using the calibrated model, we conduct a policy experiment to explore how key macroeconomic variables change over time along the transition path once the NHI coverage rate is increased. It is noteworthy that the households' decisions on work and savings as well as their welfare are influenced by how the required budget increase for the NHI coverage expansion is financed. For the experiment, we assume that the government finances the NHI coverage expansion by raising the NHI premium rate for workers.[8]

Our experiment results indicate that when the NHI coverage rate is increased, the NHI premium rate for workers is raised to finance the increased NHI budget, which distorts the households' incentive to work and thus leads to a decrease in aggregate labor. Moreover, the reduced volatility of disposable income, thanks to the increased NHI coverage rate, weakens the households' savings motive, thereby resulting in a decrease in aggregate capital. Overall, due to the lower levels of aggregate labor and capital, aggregate output decreases in our experiment. Importantly, we also find that these macroeconomic effects of the NHI coverage expansion are greater when higher NHI coverage rates are adopted.

Although our experiment reveals that the expansion of NHI coverage leads to a decline in aggregate output, it does not mean that it would result in welfare loss from the perspective of individuals. Indeed, our analysis reveals otherwise. We simulate a binary vote between keeping the NHI coverage rate at the 2015 level, 63.2 percent, and extending it to 70, 80, 90, or 100 percent, of which the result is determined by individual households' discounted lifetime expected utility. According to the simulation results, households are in favor of the NHI coverage expansion almost unanimously regardless of their age and employment status. Moreover, although the loss of aggregate output resulting from the introduction of the NHI expansion increases when population aging is considered, the binary voting simulation indicates unanimous support.

Our work bridges into a literature that concerns high medical expenses. Domowitz and Sartain (1999) claim that medical debt is one of the two strongest contributors to bankruptcy,

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[7] Most papers in the literature have two idiosyncratic shocks, labor productivity and health expenditure, which are assumed to be independent each other (see, for example, Hsu and Liao (2015)). On the contrary, following Lim (2016), we add a disability condition shock and allow interdependence between the medical expense shock and the disability condition shock, so that our model captures that households with higher medical expenses are more likely to be subject to work disability from health-related issues.

[8] According to the 2015 Health Insurance Statistics, aggregate NHI premiums consist of the premium paid by workers and the premium paid by those enrolled in the "regional health insurance program" (mostly non-workers), each accounting for 83.4% and 16.6%, respectively. The relative share between these two types of premiums, which is used as one of target moments in our calibration process, is assumed to be unchanged regardless of the introduction of the NHI coverage expansion.

with the other being credit card debt. Himmelstein et al. (2009) show that 62.1 percent of 2314 bankruptcy filers in 2007, which was a randomly sampled nationwide population, were medical. In addition, Gross and Notowidigdo (2011) point out that OOP medical expenses could be more critical to low-income households and claim that an increase in Medicaid eligibility leads to a significant decrease in household bankruptcies.

The empirical evidence on the importance of medical expenses in bankruptcies has initiated the development of theoretical frameworks that enables policy evaluation. Palumbo (1999) is among the first to incorporate uncertain medical expenses into a dynamic structural model of household consumption decisions to explain why the elderly dissave slowly. Chatterjee et al. (2007) extend Aiyagari-Bewley type models by incorporating health expenditure shocks to study the implications of a policy change in US bankruptcy filing.

The globally observed acceleration of population aging has led to a series of papers that try to quantify the macroeconomic impacts of population aging. Many have explored the financial challenge the governments would have to face to support and maintain UHC in times of rapid population aging (Hsu and Yamada (2012), Hsu et al. (2015), Hsu and Liao (2015), and Lim (2016)). Still, there have not been conclusive results on the prospect of achieving or expanding UHC, a decision which is likely to be made through a democratic voting process. Our paper contributes to the literature in that we make specific predictions on the prospect of UHC expansion by quantifying macroeconomic consequences of changes made in UHC coverage and taking individual household voting decisions into consideration.

The remainder of the paper is organized as follows. The next section presents the model, and section III describes our calibration strategy. In section IV, we perform policy experiments to quantify the macroeconomic impacts of UHC expansion and then simulate binary voting to check whether the policy of UHC expansion can expect majority support. Finally, section V concludes the paper.

II. *Model*

1. Environment

We consider a discrete time overlapping generations model. The economy is populated by a measure one continuum of ex-ante identical agents. All agents belong to either the young generation or the old generation depending on their age. In our model, the young generation is considered as the working-age population and the old generation as the retired population. Young agents have an option to work or not to work whereas old agents are forced out of the labor market. Each young agent becomes an old agent with probability π_o and each old agent is deceased with probability π_d. The deceased are replaced by "newborn" young agents, so that the population measure is constant over time: at the steady state, the measures of the young and the old are $\pi_d/(\pi_o+\pi_d)$ and $\pi_o/(\pi_o+\pi_d)$, respectively. We do not consider altruistic bequest motives for old agents; all bequests occur stochastically and the deceased's assets are equally distributed over the entire population, which is hereafter denoted by b.

Young agents are heterogeneous in their labor productivity z, medical expense m, and disability condition d, which evolve over time according to the following finite-state Markov processes with stationary transitions:

$$P_z(z'|z)=Prob(z_{t+1}\leq z'|z_t=z) \tag{1}$$

$$P_{m,d}(m', d'|m, d)=Prob(m_{t+1}\leq m', d_{t+1}\leq d'|m_t=m, d_t=d) \tag{2}$$

where t denotes time. The disability condition shock d takes one when a young agent is unable to work due to health issues and zero otherwise. We allow interdependence between the medical expense shock and the disability condition shock, as can be checked in (2), to reflect that agents with higher medical expenses are more likely to suffer from severe health issues which disengage them from working. However, labor productivity is assumed to be independent of medical expense as well as disability condition.

Old agents differ from each other only in medical expense $\tilde{m}$ which evolves with a transition probability distribution function over time as the following:

$$P_{\tilde{m}}(\tilde{m}'|\tilde{m})=Prob(\tilde{m}_{t+1}\leq\tilde{m}'|\tilde{m}_t=\tilde{m}) \tag{3}$$

Agents maximize their discounted lifetime expected utility as given by:

$$\max_{\{c_t,\ h_t\}_{t=0}^{\infty}} \mathbf{E}_0\sum_{t=0}^{\infty}\beta^t(c_t, h_t)$$

with

$$u(c_t, h_t)=\frac{c_t^{1-\sigma}-1}{1-\sigma}-B\frac{h_t^{1+1/\gamma}}{1+1/\gamma} \tag{4}$$

where β denotes the discount factor. c_t and h_t represent consumption and working hours at time t. σ and γ denote the coefficient of relative risk aversion and the elasticity of labor supply, respectively, and B measures the level of disutility resulting from working. Following Rogerson (1988) and Chang and Kim (2006), labor is assumed to be indivisible in our model. That is, h_t takes $\bar{h}$ for the young agents who decide to work (the employed) and 0 for the young agents who decide not to work and the old agents (the non-employed). 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.

The production sector consists of a representative firm that produces consumption goods according to a constant returns to scale technology given by:

$$Y=L^{\alpha}K^{1-\alpha} \tag{5}$$

where L and K denote the efficient units of labor and capital inputs, respectively, and α represents the labor income share. It is assumed that consumption goods can be transformed to capital (investment) goods without any costs, and capital used in production depreciates at the rate δ. In each period, given a wage rate for an efficiency unit of labor, w_t, and a rental rate for capital, $\tilde{r}_t$, the firm maximizes its profit by optimally choosing the levels of labor and capital inputs as follows:

$$\max_{L_t,K_t} L_t^{\alpha}K_t^{1-\alpha}-w_tL_t-\tilde{r}_tK_t \tag{6}$$

The government operates two types of social security programs: the National Health Insurance (NHI) program and the Social Insurance (SI) program. The NHI program is designed to alleviate the burden of medical expense. It pays a fraction f of each agent's (realized) medical expense, and thus the out-of-pocket medical expense of an agent with medical expense m becomes $(1-f)m$. The NHI program is financed by the compulsory NHI premium. Let τ_N and p_N denote the NHI premium rate for the employed and the NHI premium for the non-employed, respectively. The NHI premium for the employed is proportional to their labor income. That is, the NHI premium for an employed agent with labor productivity z_t is $\tau_N w_t z_t \bar{h}$ at time t. On the other hand, the NHI premium for the non-employed is p_N, which is identical across agents.[9] In our model, τ_N is endogenously determined to balance the NHI program budget at the equilibrium while p_N has a fixed, predetermined value.[10] The SI program is means-tested: only if an agent's after-tax-and-NHI-premium income falls below a minimum cost of living $y_{\min}$, the government transfers a subsidy – the minimum cost of living minus after-tax-and-NHI-premium income – to the agent. The SI program has a separate budget from the NHI program, which is financed by labor income tax, interest income tax, and consumption tax. The tax rates for labor income, interest income, and consumption are denoted by τ_h, τ_k, and τ_c, respectively.

Following Bewley (1986), Huggett (1993), Aiyagari (1994), and many other studies in the literature, the financial market is incomplete in the sense that there are no contingent claims available and that the only asset available in the market is physical capital, a. In addition, we assume that agents confront the borrowing constraint $a_t \geq \underline{a}$, as in Aiyagari (1994). To secure against idiosyncratic shocks, risk averse agents accumulate assets, on which the rate of return, r_t, is competitively determined at the equilibrium: $r_t = \tilde{r}_t - \delta$

2. Recursive Formulation

In the beginning of each period, young agents make a labor supply decision after observing their (realized) labor productivity, medical expense, and disability condition. Let $V_y(z, m, d, a)$ denote the value function of a young agent indexed by (z, m, d, a). If the agent is "able" $(d=0)$, she has the option to work or not; thus, her value function is expressed as follows:

$$V_y(z, m, 0, a) = \max_{h(z,m,0,a)\in\{\bar{h},0\}} [V_y^E(z, m, 0, a), V_y^U(z, m, 0, a)] \tag{7}$$

where V_y^E (V_y^U) denotes the value function when she chooses to work (not to work), and h represents the labor supply decision, which takes $\bar{h}$ (0) when she chooses to work (not to work).[11] On the other hand, a "disabled" agent $(d=1)$ can't participate in the labor market and her value function is simply given by:

$$V_y(z, m, 1, a) = V_y^U(z, m, 1, a) \tag{8}$$

[9] The non-employed consist of young agents who decide not to work and all old agents.

[10] We calibrate p_N so that the share of non-workers' premium in aggregate revenue of the NHI program closely matches the data.

[11] We drop the arguments of the value functions and the policy function for ease of notation.

The value function of the employed young agent, V_y^E, can be represented as the following:

$$V_y^E(z, m, 0, a) = \max_{c\geq 0,\, a'\geq \underline{a}} u(c, \bar{h}) + \beta\{(1-\pi_o)\mathbf{E}[V_y(z', m', d', a') \mid z, m, d=0] + \pi_o \mathbf{E}[V_o(\tilde{m}', a') \mid m]\} \tag{9}$$

subject to

$$(1+\tau_c)c + (1-f)m + a' = D_y^E(z,a) + T_y^E(z, m, a) \tag{10}$$

$$D_y^E(z, a) = (1-\tau_h-\tau_N)wz\bar{h} + \{1+(1-\tau_k)r\}(a+b) \tag{11}$$

$$T_y^E(z, m, a) = \max\{0, (1+\tau_c)y_{\min} - D_y^E(z, a) - (1-f)m\} \tag{12}$$

The employed young agent maximizes lifetime expected utility by optimally determining levels of consumption c and savings a' subject to the budget constraint (10). As seen in (10), the agent has two income sources: disposable income which is the sum of after-tax-and-NHI-premium labor income and after-tax interest income on savings and any accidental bequests, D_y^E, and the government transfer, T_y^E, that guarantees the minimum cost of living $y_{\min}$.[12]

The value function of the non-employed young agent, V_y^U, can be represented as the following:

$$V_y^U(z, m, d, a) = \max_{c\geq 0,\, a'\geq \underline{a}} u(c, 0) + \beta\{(1-\pi_o)\mathbf{E}[V_y(z', m', d', a') \mid z, m, d] + \pi_o \mathbf{E}[V_o(\tilde{m}', a') \mid m]\} \tag{13}$$

subject to

$$(1+\tau_c)c + (1-f)m + a' = D_y^U(a) + T_y^U(m,a) \tag{14}$$

$$D_y^U(a) = \{1+(1-\tau_k)r\}(a+b) - p_N \tag{15}$$

$$T_y^U(m, a) = \max\{0, (1+\tau_c)y_{\min} - D_y^U(a) - (1-f)m\} \tag{16}$$

The value function of the non-employed agent is different from that of the employed agent in two aspects: (i) the agent needs not suffer from working, and (ii) disposable income is the interest income from savings net of the NHI premium p_N.

The value function of the old agent, V_o, is represented in a similar manner to that of the non-employed young agent, V_y^U:

$$V_o(\tilde{m}, a) = \max_{c\geq 0,\, a'\geq \underline{a}} u(c, 0) + \beta\{(1-\pi_d)\mathbf{E}[V_o(\tilde{m}', a') \mid \tilde{m}]\} \tag{17}$$

subject to

$$(1+\tau_c)c + (1-f)\tilde{m} + a' = D_o(a) + T_o(\tilde{m},a) \tag{18}$$

$$D_o(a) = \{1+(1-\tau_k)r\}(a+b) - p_N \tag{19}$$

[12] Note that the bequests are accidental in the sense that all bequests occur stochastically and the deceased's assets are equally distributed over the entire population.

$$T_o(\tilde{m}, a) = \max\{0, (1+\tau_c)y_{\min} - D_o(a) - (1-f)\tilde{m}\} \tag{20}$$

3. Stationary Competitive Equilibrium

Let s_y and s_o denote the young agent's state variables (z, m, d, a) and the old agent's state variables $(\tilde{m}, a)$, respectively. The stationary competitive equilibrium consists of (i) value functions $\{V_y(s_y), V_y^E(s_y), V_y^U(s_y)\}$ and policy functions $\{h(s_y), c(s_y), a'(s_y)\}$ of the young agent, (ii) value function $V_o(s_o)$ and policy functions $\{c(s_o), a'(s_o)\}$ of the old agent, (iii) firm decisions on production factors $(L^\star, K^\star)$, (iv) a price system $(w^\star, r^\star)$, (v) a NHI premium rate for the employed $\tau_N^\star$, (vi) government transfers $\{T_y^E(s_y), T_y^U(s_y), T_o(s_o)\}$, (vii) government consumption G, and (viii) measures of the young population and the old population $\{\Phi_y(s_y), \Phi_o(s_o)\}$, such that the following hold.

1. Given the price system $(w^\star, r^\star)$, agents in each generation optimize:
   (a) the value functions and the policy functions of the young agent, $\{V_y, V_y^E, V_y^U\}$ and $\{h, c, a'\}$, solve the Bellman equations (7), (8), (9), and (13).
   (b) the value function and the policy functions of the old agent, V_o and $\{c, a'\}$, solve the Bellman equation (17).

2. The firm maximizes its profit:

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

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

3. The factor markets clear:

$$L^\star = \bar{h}\int x1\{h(s_y) = \bar{h}\}\mathrm{d}\Phi_y$$

$$K^\star = \int a\mathrm{d}\Phi_y + \int a\mathrm{d}\Phi_o + b.$$

4. The government balances the budget of each social security program:
   (a) the NHI program budget is balanced:

$$\tau_N^\star w^\star L^\star + p_N\left\{\int 1\{h(s_y)=0\}\mathrm{d}\Phi_y + \int \mathrm{d}\Phi_o\right\} = f\left\{\int m\mathrm{d}\Phi_y + \int \tilde{m}\mathrm{d}\Phi_o\right\}$$

   where the L.H.S and the R.H.S denote the revenue and the expenditure of the NHI program, respectively; and

   (b) the SI program budget is balanced:

$$\tau_c\left\{\int c\mathrm{d}\Phi_y + \int c\mathrm{d}\Phi_o\right\} + \tau_k r^\star\left\{\int a\mathrm{d}\Phi_y + \int a\mathrm{d}\Phi_o\right\} + \tau_h w^\star L^\star =$$

TABLE 1. EXTERNALLY CALIBRATED PARAMETERS

Parameter	Description	Source (or Target Moment)
π_o=20.4%	Probability of becoming aged	Work-life expectancy, 49 years
π_d=11.4%	Probability of dying	2013 Korea old-age dependency ratio, 17.9%
σ=1.0	Risk-aversion parameter	Literature
γ=0.4	Labor supply elasticity	Chang and Kim (2007)
ρ_z=0.79	$\log z'=\rho_z \log z+\epsilon_z$,	Lim (2016)
σ_z=0.35	where $\epsilon_z \sim N(0,\sigma_z^2)$	Lim (2016)
$\bar{h}$=1/3	Working hours	Literature
α=0.60	Labor income share	Literature
δ=0.06	Depreciation rate	Literature
τ_c=10.0%	Consumption tax rate	2015 Korea value-added tax rate
τ_k=15.4%	Interest income tax rate	2015 Korea
τ_h=20.0%	Labor income tax rate	Lim (2016)
f=63.2%	NHI coverage rate	2014 Korea

$$G+\int T_y^E \mathrm{d}\Phi_y+\int T_y^U \mathrm{d}\Phi_y+\int T_o \mathrm{d}\Phi_o$$

where the L.H.S and the R.H.S denote the revenue and the expenditure of the SI program, respectively.[13]

5. The measures of the young population and the old population are invariant over time.

III. *Calibration*

We calibrate the model so that the steady state economy (the benchmark economy) replicates selected observations of the 2015 Korean economy. We divide the parameters of the model into two sets: one that either can be externally calibrated without consideration of the frame of the model, or has been previously estimated in the literature, and one that needs to be calibrated strictly within the frame of the model. The calibration of the shock processes for the medical expense and the disability condition is discussed separately.

The parameters that belong to the former are summarized in Table 1. We consider agents aged from 15 to 64 as the working-age population. We set the probability of a young agent's becoming aged, π_o, to 20.4 percent so that the work-life expectancy in our model becomes 49 years (one period in our model corresponds to one year). Given π_o (=20.4%), we set the value for the probability of an old agent's dying, π_d (=11.4%), so that the old-age dependency ratio in our model matches that of 2013 Korea, 17.9 percent. The risk aversion parameter, σ, is set to 1.0 which is a widely-used value in the literature, and the elasticity of labor supply, γ, to 0.4 as in Chang and Kim (2007). The stochastic process for labor productivity z is assumed to follow a first order autoregressive process in logarithms: $\log z'=\rho_z \log z+\epsilon_z$ with $\epsilon_z \sim N(0, \sigma_z^2)$, and we take the values for ρ_z (=0.79) and σ_z (=0.35) from Lim (2016). Following the literature, we set the working hours of the employed, $\bar{h}$, to 1/3, the labor income share, α, to 0.60, and the depreciation rate, δ, to 0.06. As of 2015, the value-added tax rate and the interest income tax

[13] In our model, the government consumption G is mechanically determined to balance the budget of the SI program.

TABLE 2. INTERNALLY CALIBRATED PARAMETERS

Parameter	Description	Target Moment
β=0.962	Discount factor	Real interest rate, 4.0%
B=167.0	Disutility from working	Employment ratio, 64.0%
$y_{\min}$ =0.006	Minimum cost of living	Percentage of SI recipients, 4.17%
p_N=0.011	NHI premium for non-worker	Workers' premium to total NHI premium, 83.4%

Note: Each of the model-generated moments has the same value (up to three decimal places) as its corresponding data moment.

TABLE 3. STATUS OF MEDICAL EXPENSE

Group		Avg. Medical Expense (₩)	Ratio to Bottom 60% of Young
Young	Bottom 60%	24,052	1.0
	60-95%	398,056	16.6
	95-99%	2,035,906	84.6
	Top 1%	7,608,484	293.9
Old	Bottom 60%	132,997	5.5
	60-95%	1,068,230	44.4
	95-99%	4,521,900	188.0
	Top 1%	13,158,182	547.1

Source: Lim (2016)

rate in Korea are 10.0 and 15.4 percent, and so the values for the consumption tax rate, τ_c (= 10.0%) and the interest income tax rate, τ_k (=15.4%), are assigned correspondingly. The labor income tax rate, τ_h, is set to 20.0 percent following Lim (2016). The coverage rate of the NHI program, f, in our benchmark economy is 63.2 percent to match that of 2014 Korea.

Table 2 lists the parameters that have been calibrated strictly within the frame of our model. The discount factor, β, is closely linked to the equilibrium interest rate since it affects the shape of capital supply curve. We set β=0.962 so that the real interest rate is 4.0 percent at the equilibrium. The weight parameter on disutility from working, B, is set to 167.0 so that the model economy matches the average employment rate for 2009-2014 in Korea, 64.0 percent. We set the value of the minimum cost of living, $y_{\min}$ (=0.006), such that the model economy matches the percentage of SI program subsidy recipients of 2015 Korea, 4.17 percent. As of 2015, the collected premiums from the employed account for 83.4 percent of aggregate NHI premium. For the model economy to reflect this, the NHI premium for the non-employed, p_N, is set to 0.0108.

Following Hsu (2013) and Lim (2016), we discretize the state spaces of the medical expense shock for young agents and old agents by $\{m_1, m_2, m_3, m_4\}$ and $\{\tilde{m}_1, \tilde{m}_2, \tilde{m}_3, \tilde{m}_4\}$, respectively, with a bigger subscript representing a higher expense. Using the 2008 Korean Health Panel, Lim (2016) divided the young generation (the old generation) into four groups by the level of medical expense: (i) the bottom 60%, (ii) 60 to 95%, (iii) 95 to 99%, and (iv) the top 1%. Lim (2016) then calculated the average medical expense for each group as reported in Table 3.[14] The average medical expense of each group relative to the bottom 60% of young agents is 1.0, 16.6, 84.6, and 293.9 for the young generation and 5.5, 44.4, 188.0, and 547.1 for

[14] Lim (2016) used the terminology "health shock" instead of medical expense shock.

TABLE 4. JOINT TRANSITION MATRIX FOR MEDICAL EXPENSE AND DISABILITY CONDITION: YOUNG

		Next Period's State							
		$(G_1,0)$	$(G_1,1)$	$(G_2,0)$	$(G_2,1)$	$(G_3,0)$	$(G_3,1)$	$(G_4,0)$	$(G_4,1)$
Current State	$(G_1,0)$	76.4	0.1	20.7	0.0	2.1	0.0	0.7	0.0
	$(G_1,1)$	21.1	56.3	5.6	14.1	0.0	2.8	0.0	0.0
	$(G_2,0)$	36.0	0.1	56.9	0.4	5.6	0.0	1.0	0.0
	$(G_2,1)$	7.6	17.4	25.0	37.0	4.3	4.3	0.0	4.3
	$(G_3,0)$	31.2	0.3	49.0	1.0	12.8	1.5	4.2	0.0
	$(G_3,1)$	12.5	9.4	18.8	37.5	6.3	12.5	0.0	3.1
	$(G_4,0)$	26.3	0.0	44.2	1.9	15.4	1.9	6.4	3.8
	$(G_4,1)$	0.0	7.1	7.1	14.3	7.1	35.7	7.1	21.4

Note: Each cell represents the probability of transitioning from the current state (G_i,d_j) to the next period's state (G_k, d_l) where G_i (G_k) denotes the medical expense group with a greater subscript value indicating a group with a higher level of medical expense and d_j (d_l) denotes the disability condition; Units are in percent.
Source: Lim (2016)

TABLE 5. TRANSITION MATRIX FOR MEDICAL EXPENSE: OLD

%	G_1	G_2	G_3	G_4
G_1	79.3	17.6	2.1	1.0
G_2	31.4	60.5	6.7	1.4
G_3	29.1	64.1	2.9	3.9
G_4	20.0	47.5	17.5	15.0

Note: The i-th row and j-th column element represents the probability of transitioning from G_i to G_j where a greater subscript value for the medical expense group indicates a group with a higher level of medical expense.
Source: Lim (2016)

the old generation. While maintaining these ratios, we set the value of m_1 to 2.906 so that the ratio of aggregate medical expenditure to GDP matches the corresponding ratio of 2013 Korea, 7.2 percent. The joint transition probability matrix for medical expense and disability condition shocks for the young (working-age population) and the transition probability matrix for medical expense for the old (retired population) are given in Table 4-5, which are taken from Lim (2016).[15]

IV. *Policy Experiment*

Using the calibrated model, we perform policy experiments to analyze what happens to the economy if the government increases the coverage rate of the NHI program. In particular, we assume that the NHI premium rate for the employed, τ_N, is raised to finance the increased budget of the NHI program.

[15] Lim (2016) calculated the transition probability matrices using the 2008-2009 Korean Health Panel.

Table 6. Comparative Statics

NHI Coverage Rate (%)	63.2	70	80	90	100
NHI Expenditure	1	1.108	1.266	1.424	1.582
NHI Premium Rate (%)	6.3	7.2	8.5	9.8	11.1
Aggregate Capital	1	0.990	0.975	0.958	0.939
Aggregate Labor	1	0.996	0.990	0.984	0.977
Aggregate Output	1	0.994	0.984	0.973	0.961

Note: NHI expenditure, aggregate capital, aggregate labor, and aggregate output are normalized by the benchmark level of each variable.

1. Comparative Statics

Table 6 compares key macroeconomic variables of the steady states of the model economies that are identical to the benchmark economy except for the NHI coverage rate: 63.2 (benchmark economy), 70, 80, 90, and 100 percent. It is clear that the total expenditure of the NHI program increases with the NHI coverage rate. In the economy with full NHI coverage, for example, the total expenditure of the NHI program is 58.2 percent higher than in the benchmark economy. As a result, the (budget-balancing) NHI premium rate for the employed increases to 11.1 percent from 6.3 percent in the benchmark economy.

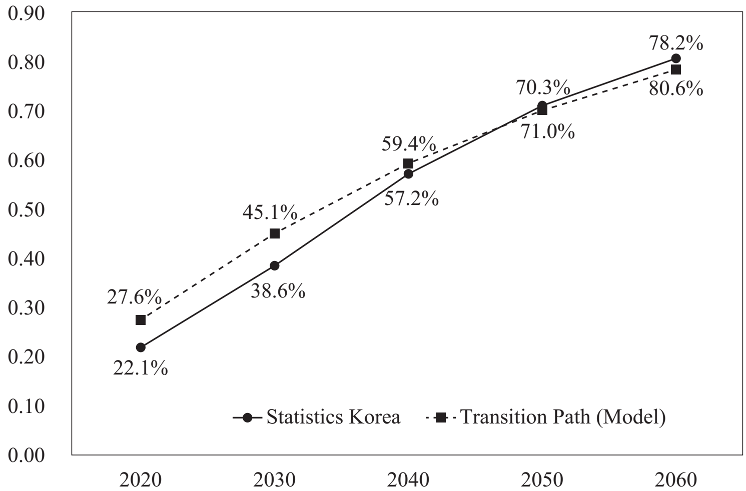
How does the policy of expanding NHI coverage and the resulting increase in the NHI premium rate affect the economy? First, the enlarged NHI coverage weakens precautionary savings motive of households. Due to the incomplete financial market, each agent in the model accumulates assets to smooth consumption over time to secure against medical expenses, disability, and labor productivity shocks. Since the increase in the NHI coverage rate reduces the volatility of disposable income, after taking into consideration the out-of-pocket medical expense, agents are less likely to save in an economy with a higher NHI coverage rate, given all else being equal. Consequently, aggregate capital decreases with the NHI coverage rate: aggregate capital in the economy with full NHI coverage is 6.1 percent lower than in the benchmark economy. Second, the increase in the NHI premium rate results in a decrease in the effective labor income of the employed, and thus some marginal workers might no longer participate in the labor market, which leads to decreases in aggregate labor: aggregate labor is 2.3 percent lower in the economy with full NHI coverage compared to the benchmark economy. Finally, due to the decreases in both aggregate labor and capital, aggregate output decreases as the NHI coverage rate increases: aggregate output in the economy with full NHI coverage is 3.9 percent lower than in the benchmark economy.

2. Transition Path

In this subsection, we study how the economy, once a new extended NHI coverage policy is introduced, evolves over time. Since Korea is one of the fastest aging countries in the world and so NHI expenditure is expected to increase rapidly, it is crucial to understand the impact of population aging when it comes to the discussion of any NHI coverage expansion policy. Thus, we compare the transition paths of the non-aging economy with those of the aging economy.

To generate the transition paths of the aging model economy, following Lim (2016), we

FIGURE 1. OLD-AGE DEPENDENCY RATIO ALONG TRANSITION PATH



Source: Statistics Korea (2012); Lim (2016).

lower the value of the probability of dying, π_d, from 11.4 to 2.1 percent, so that the old-age dependency ratio along the transition paths can closely match the projected old-age dependency ratio provided by Statistic Korea (2012) (see Figure 1).

Non-aging Economy

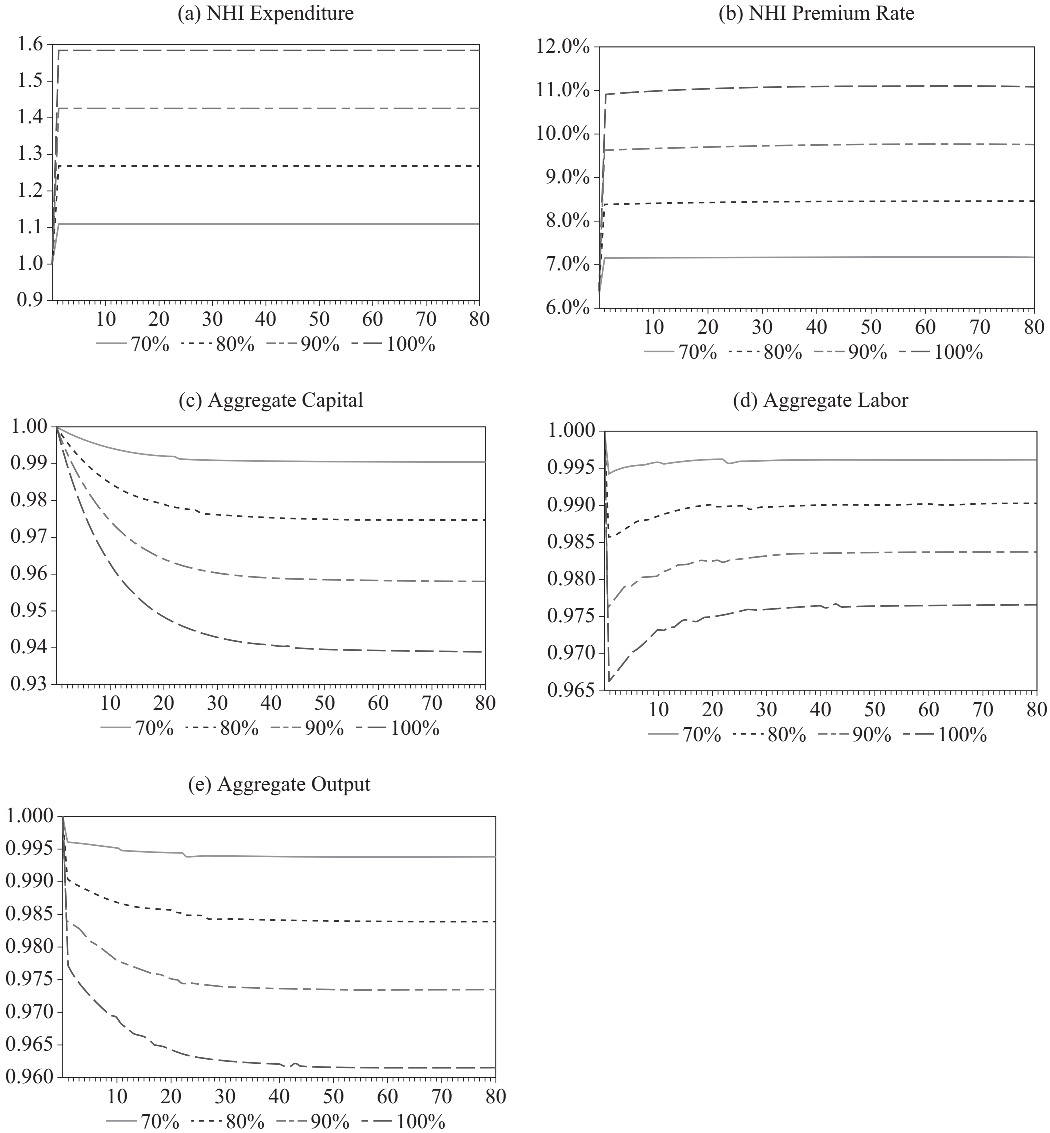
We start with the analysis of the transition paths of the non-aging economy.[16] We consider four different scenarios in which the economy is in the steady state at time 0 and the government increases the NHI coverage rate from 63.2 percent (benchmark) to 70, 80, 90, or 100 percent at time 1. Figure 2 summarizes how key macroeconomic variables change along the transition paths. For illustrative purposes, we normalize NHI expenditure, aggregate capital, aggregate labor, and aggregate output by the benchmark level (the level at time 0) of each variable.

When a new NHI coverage rate is introduced at time 1, NHI expenditure immediately reaches the level of the new steady state.[17] The budget-balancing NHI premium rate for the employed soars up to meet the NHI program's budget and it gradually increases afterward. As discussed in the previous subsection, the expanded NHI coverage reduces the volatility of disposable income and it reduces the precautionary savings motive. Those who are newly born since the introduction of the new extended NHI coverage save less than they would have without the expansion of the NHI coverage, and those who were born before the new NHI coverage is introduced dissave over time. As a result, aggregate capital keeps decreasing over time. Importantly, aggregate capital decreases more when a higher NHI coverage rate is

[16] The probability of dying π_d is assumed to be unchanged in the non-aging economy.

[17] It is because the shock process for medical expense is unchanged and the population measure is invariant in our model.

Figure 2. Transition Path: Non-aging Economy



Note: The horizontal axis in each graph represents time. Time 0 corresponds to 2015.

adopted because a higher coverage rate means less volatile disposable income for agents (see Figure 2 (c)).

In addition, as the increase in the NHI premium rate distorts the agents' incentive to work, aggregate labor plummets at time 1, more severely when a higher NHI coverage rate is introduced, and subsequently it rebounds to reach the new steady state level, which is lower than the level at time 0 (see Figure 2 (d)). The reason for the presence of overshooting is that some of those who have left the labor market due to the overly reserved savings come back to work once they dissave assets enough to reach a new optimal level. Finally, the decreases in both aggregate labor and capital result in decreases in aggregate output as confirmed in Figure 2 (e).

Aging Economy

Figure 3 summarizes how key macroeconomic variables change along the transition paths if the government increases the NHI coverage rate from the current 63.2 percent (2015 level) to 70, 80, 90, or 100 percent at time 1. Figure 3 also illustrates how the economy without the introduction of the NHI coverage expansion evolves over time as its population is aging, which is denoted by the solid line. For illustrative purposes, we normalize the NHI expenditure, aggregate capital, aggregate labor, and aggregate output by the benchmark level (the level at time 0) of each variable.

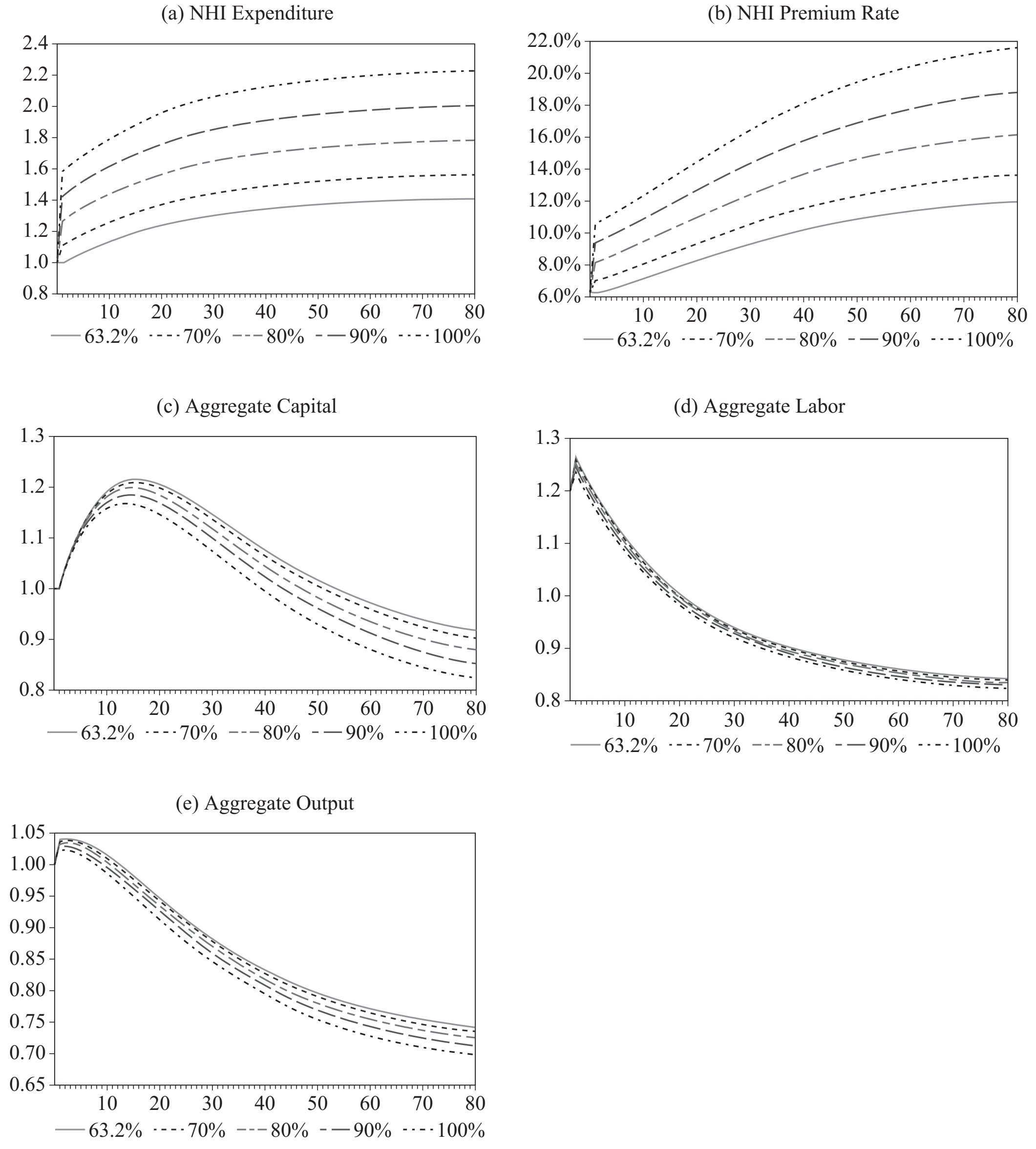
Figure 3 (a) and (b) show that even without the introduction of the NHI coverage expansion, NHI expenditure and the NHI premium rate for the employed gradually increase as the economy ages. With the introduction of the NHI coverage expansion, NHI expenditure immediately increases at time 1 and then shows a gradual increase over time. For the NHI budget to be balanced, the NHI premium rate for the employed increases over time with an initial jump at time 1. Note that the extent to which NHI expenditure and the NHI premium rate for the employed increase in response to the NHI coverage expansion is greater when a higher coverage rate is adopted.

The increase in the NHI coverage rate weakens the precautionary savings motive, which would have resulted in the decrease in aggregate capital had it not been for the population aging, as discussed earlier. However, in the aging economy, agents need to adjust their savings plan by increasing assets in preparation for the extended life expectancy, which leads to the increase in aggregate capital. Our analysis shows that during the initial period of the transition, the latter effect (aging effect) is greater than the former effect, and thus aggregate capital increases. However, newborn agents that can make and keep their savings plan at birth for the invariable higher life expectancy keep replacing (deceased) old agents who would have been forced to adjust their savings plan to the changed life expectancy in the middle of their life. Therefore, aggregate capital eventually decreases (see Figure 3 (c)). It is noteworthy that the levels of aggregate capital are lower in economies with higher NHI coverage rates throughout the transition path because a higher rate of NHI coverage means less volatile disposable income to agents.

Figure 3 (d) shows that aggregate labor immediately increases at the time of the introduction of the NHI coverage expansion, but it keeps decreasing afterward. The reason for the initial increase in aggregate labor is that agents are more likely to work to save more for the extended life expectancy. However, as the fraction of the population who are young declines over time, aggregate labor decreases.

According to Figure 3 (e), aggregate output increases at time 1 due to the increases in both production factors and it keeps decreasing afterwards; during the period in which aggregate capital increases, aggregate output decreases more slowly than other times. Lastly, as the levels of aggregate labor and capital are lower in economies with higher NHI coverage rates throughout the transition path, so is the level of aggregate output.

Figure 3. Transition Path: Aging Economy



Note: The horizontal axis in each graph represents time. Time 0 corresponds to 2015.

TABLE 7. APPROVAL RATE FOR NHI COVERAGEEXPANSION: NON-AGING ECONOMY

NHI Coverage Rate	70	80	90	100
Entire Population	99.6	99.7	99.7	99.7
The Young	99.5	99.6	99.7	97.7
- The Employed	99.3	99.4	99.5	99.5
- The Non-employed	100.0	100.0	100.0	100.0
The Old	100.0	100.0	100.0	100.0

Note: The units are in percent.

TABLE 8. APPROVAL RATE FOR NHI COVERAGE EXPANSION: AGING ECONOMY

NHI Coverage Rate	70	80	90	100
The Young	100.0	100.0	100.0	100.0
The Old	100.0	100.0	100.0	100.0

Note: The units are in percent.

3. Voting

The NHI coverage expansion results in the shrinkage of aggregate output, yet the purpose of expanding health insurance coverage is to enhance welfare, potentially even at a cost of other economic outcomes. Thus, two natural questions arise: (i) how does the NHI coverage extension affect individual welfare? (ii) can it be supported by agents in a political sense? To provide answers to these questions, we simulate a binary vote between several economies: the benchmark economy with a coverage rate of $f_0 = 63.2\%$ and the economies with the extended coverage rates of $f_1 \in \{70\%, 80\%, 90\%, 100\%\}$. For the simulation, we assume that the government considers to expand the NHI coverage at the beginning of time 1 right after the idiosyncratic shocks are realized. Agents would vote for or against the policy of expanding NHI coverage depending on its impact on their discounted lifetime expected utility. That is, a young agent indexed by (x, m, d, a) would vote for the NHI coverage expansion only if $V_y(x, m, d, a; f_1) \geq V_y(x, m, d, a; f_0)$ at time 1. Similarly, an old agent indexed by $(\tilde{m}, a)$ would vote for the NHI coverage expansion only if $V_o(\tilde{m}, a; f_1) \geq V_o(\tilde{m}, a; f_0)$ at time 1. With the measures of the young and the old populations, $\Phi_y(s_y; f_0)$ and $\Phi_o(s_o; f_0)$ at time 1, we can compute the approval rate for the NHI coverage expansion.

Table 7 summarizes the approval rates for the four different NHI coverage rates, 70, 80, 90, and 100 percent, for the case of the non-aging economy. The approval rate of the entire population for the 70% NHI coverage rate is 99.6 percent and it increases slightly with the coverage rate to hit 99.7 percent for full NHI coverage. The old and the young non-employed who would be able to enjoy the enhanced benefit without any additional costs unanimously support the NHI coverage extension for all the coverage rates considered. The approval rate of the young employed agents who shoulder the burden of the increased NHI premium is close to unanimity: 99.3, 99.4, 99.5, and 99.5 percent for the 70, 80, 90, and 100 percent NHI coverage rate, respectively.

Finally, if population aging is taken into consideration, the NHI coverage expansion is unanimously supported regardless of the coverage rate, as shown in Table 8. That is, the approval rate for the NHI coverage expansion increases with the consideration of the population aging process.

V. *Conclusion*

Korea is often cited as one of most successful cases for the rapid achievement of UHC. However, the low contribution and limited benefit coverage strategy throughout the process of achieving UHC came at the cost of a high level of OOP medical payments. In step with growing global interest in UHC, the Korean government pronounced a goal to expand UHC in 2015.

In this paper, we quantify the macroeconomic impacts of the UHC coverage expansion and examine whether it can be supported by majority rule. Our analysis shows that when UHC coverage is expanded, the UHC premium rate for workers is raised to finance the increased UHC budget, which distorts the agents' incentive to work and leads to a decrease in aggregate labor. Moreover, the reduced volatility of disposable income, thanks to the expansion of UHC, weakens the agents' savings motive, thereby resulting in a decrease in aggregate capital. Overall, due to the lower levels of aggregate labor and capital, aggregate output decreases. Importantly, we also find that these macroeconomic effects of the UHC coverage expansion are greater when higher UHC coverage rates are adopted.

While the decreases in production factors lead to a significant drop in aggregate output, the binary voting simulation shows that the expansion of UHC is approved with near-unanimous support. In addition, although the loss of aggregate output resulting from the introduction of the UHC expansion increases once population aging is considered, the binary voting simulation indicates unanimous support.

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