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Public health expenditure, social security, and fertility

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1. Introduction

As an economy grows, its pattern of demographic transition changes, becoming increasingly characterized by low mortality and low fertility. Such longer life span affects not only private saving behavior, but also child-bearing behavior. Children enhance parents' utility and generate increased costs, such that greater longevity causes the agent to save more for life after retirement. This condition gives a disincentive to having children because of child care costs.

One factor prolonging life, among others, is public health expenditure.[1] Public health expenditures extend longevity and affect the social security system, which secures the life risk upon retirement. Public health contributes to the increase in the number of elderly people who face life risk, which is why the government pays more social security benefits to elderly people. To resolve related issues, a government that incorporates public health expenditure and social security adopts public policy to enhance fertility and to increase the total population.[2]

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[1] As demonstrated by the Organization for Economic Co-operation and Development (OECD) (2010), the ratio of public health expenditure to total health expenditure of the US increased from 44.9 percent in 1995 to 46.5 percent in 2008. That of Italy also increased from 70.8 percent in 1995 to 77.2 percent in 2008. In OECD countries, the ratio of public health expenditure is expected to continue to increase, thus serving a critical function in national health.

[2] Empirical studies on the effects of social security on private saving and the fertility decision have been presented by Cigno and Rosati (1992), Cigno and Rosati (1996), Cigno and Rosati (1997), Ehrlich and Zhong (1998), Cigno, Casolaro and Rosati (2003), Zhang and Zhang (2004), and others.

According to a study by Becker and Barro (1988), social security might affect private saving and the demand for children.[2] Introducing parents' child-care costs into the model, Zhang and Zhang (1998) show that a higher social security tax rate tends to be detrimental to economic growth and welfare. Incorporating an uncertain lifetime into Zhang and Zhang (1998), Yakita (2001) shows that an increasing life expectancy lowers fertility and that pay-as-you-go social security does not reverse fertility.[3] However, some room exists for us to examine the effects of public health expenditure on fertility and welfare because public health expenditures are not included in these models.

As regards discussion on public health care and social security, Chakraborty (2004) examines how extending longevity by augmenting public health expenditure is conducive to growth and shows that high-mortality societies do not grow rapidly because a shorter lifespan discourages savings. Zhang, Zhang, and Leung (2006) study the effects of social security and health subsidies on private savings, private health investment, and welfare in the overlapping-generations model. Pestieau, Ponthiere, and Sato (2008) show that the sign of an optimal subsidy on health expenditures tends to be negative when the replacement ratio is sufficiently large. In these discussions, the effects of public health expenditure to extend longevity on fertility are excluded. We can examine the connections among public health expenditure, social security, and fertility using an overlapping-generations model.

As described in this paper, introducing public health expenditure and longevity into the overlapping-generations model with social security, we examine the effects of public health expenditure and social security benefits on fertility and welfare.[4]

To clarify how public health expenditure and social security benefits affect fertility decisions and welfare, we examine the effects of different types of income taxes on fertility and welfare. When the government budget constraint is decoupled and dedicated taxes are levied on both public health expenditure and social security benefits, we can consider the effect of health tax (tax for public health expenditure) on fertility and welfare while

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[3] Omori (2009) analyzes social security and public education in a model with endogenous fertility.

[4] Andersen (2005), Bovenberg and Uhlig (2006), Andersen(2008), and others discuss the relationship between life risk and social security. Expanding longevity through public health expenditure causes consumers to face life risk more, causing them to need savings and social security to minimize such risk. In other words, based on the literature, this paper discusses the relationship between life risk, which public health expenditure affects, and social security.

maintaining the social security tax (tax for social security benefits) constant and that of social security tax with a constant health tax. These different financing mechanisms might present different implications for fertility and welfare and might clarify how parents' decisions on children depend on public health expenditure and/or social security benefits.

The question addressed in this paper is the following: When a government budget constraint is decoupled and dedicated taxes are levied on both for public health expenditure and for social security, how can such taxes affect fertility and welfare?

The remainder of the paper is organized as follows: Section 2 presents the model. Section 3 presents optimal plans for the consumer in equilibrium. Based on Section 3, Section 4 clarifies the effects of a health tax and a social security tax on fertility and welfare. The last section presents concluding remarks.

2. Model

As developed by Diamond (1965), we consider an overlapping-generations model of a small open economy.[5] For simplicity, we assume that the world interest rate remains constant over time. The capital labor ratio and wage rate are also constant. The economy comprises identical three-period-lived agents, perfectly competitive firms, and a government. The production technology is assumed to be governed by a standard neoclassical constant-returns-to-scale production function.

2.1 Consumers

Agents in the first period of their lives, the young generation, are raised by their parents. Agents in the second period of their lives, the working generation, supply their labor to firms inelastically.[6] These agents divide their after-tax income among current consumption, savings for consumption when old, and child-raising expenditures.

With probability p_t, an agent who worked during period t will live throughout old age, and with probability $1-p_t$, the agent will die before the onset of the third period, old age.

[5] To keep the analysis simple, we develop the overlapping-generations model in a small open economy. We can also develop a similar model in a closed economy. The path in a closed economy might not be fundamentally different from that in a small open economy.

[6] In Appendix A, when we introduce the labor-leisure choice into the model, we show the dynamic system.

In this model, similar to that presented by Chakraborty (2004) and Pestieau et al. (2008), when introducing longevity into the overlapping-generations model, we assume that the probability of survival, p_t, is the same for all individuals.

Agents in the final period of their lives, the older generation, consume social security benefits and accumulated savings. Accidental bequests emerge if an agent dies at the onset of old age. However, introducing an annuity market into the model, we do not presume accidental bequests. The return in the annuity market at period t is the interest rate, $1 + r$, divided by $p_{t-1}\left(i.e., \frac{1+r}{p_{t-1}}\right)$.

The working generation at period t is called generation t, such that the preference of a representative agent of generation t is

$$u\left(c_w^t,\ c_o^t,\ n_{t+1}\right) = \ln c_w^t + p_t \ln c_o^t + \epsilon \ln n_{t+1}, \tag{1}$$

where c_w^t and c_o^t respectively denote the consumption of generation t during the working generation period and the old period, n_{t+1} is the number of children, and l^t is the leisure for generation t. Let N_t be the total working generation population at period t. Therefore, we have $N_{t+1} = (1 + n_{t+1})N_t$.[7]

The budget constraints of a representative agent of generation t in the working and old periods are given respectively as

$$c_w^t + s^t + \Lambda n_{t+1} = \left(1 - \tau_H - \tau_s\right) w, \tag{2}$$

and

$$c_o^t = \left(\frac{1+r}{p_t}\right) s^t + T_{t+1}, \tag{3}$$

where s^t signifies savings, Λ represents the parents' child cost per child, τ_H stands for the wage income tax rate for public health expenditure, τ_s is the wage income tax rate for social security benefits, w is the wage rate, and T_{t+1} is the social security benefits at $t + 1$.

Given the wage rate, interest rate, wage income tax rates, probability of surviving, and the child-care cost per child, a representative agent chooses c_w^t, c_o^t, and n_{t+1} to maximize utility, (1), subject to the budget constraints, (2) and (3). The first-order conditions are

[7] Similar to Omori (2009), to show the population growth explicitly, we define this variable as $N_{t+1} = (1 + n_{t+1})N_t$. However, even when we define population growth as $N_{t+1} = n_{t+1}N_t$, we can derive similar implications.

the followings:

$$\frac{1}{c_w^t} = \lambda, \tag{4}$$

$$\frac{p_t}{c_o^t} = \frac{p_t \lambda}{1+r}, \tag{5}$$

$$\frac{\epsilon}{n_{t+1}} = \lambda \Lambda, \tag{6}$$

and

$$(1 - \tau_H - \tau_s)\, w - c_w^t - \frac{p_t c_o^t}{(1+r)} + \frac{p_t T_{t+1}}{(1+r)} - \Lambda n_{t+1} = 0. \tag{7}$$

Therein, λ is a Lagrangian multiplier.

Based on the first-order conditions, the optimal plans for c_w^t, c_o^t, and n_{t+1} are respectively

$$c_w^t = \frac{1}{(1 + p_t + \epsilon)} \left[(1 - \tau_H - \tau_s)\, w + \frac{p_t T_{t+1}}{1+r} \right], \tag{8}$$

$$c_o^t = \frac{(1+r)}{(1 + p_t + \epsilon)} \left[(1 - \tau_H - \tau_s)\, w + \frac{p_t T_{t+1}}{1+r} \right], \tag{9}$$

and

$$n_{t+1} = \frac{\epsilon}{(1 + p_t + \epsilon)\, \Lambda} \left[(1 - \tau_H - \tau_s)\, w + \frac{p_t T_{t+1}}{1+r} \right]. \tag{10}$$

Substituting (9) into (3), the saving function, s^t, is

$$s^t = \frac{p_t}{(1 + p_t + \epsilon)} \left[(1 - \tau_H - \tau_s)\, w - \frac{T_{t+1}\,(1 + \delta + \epsilon)}{(1+r)} \right]. \tag{11}$$

2.2 Government

The government is assumed to behave under a balanced budget regime. Tax revenues are collected to finance public health expenditure and social security benefits in the current period.

We presume that the agents enjoy public health expenditures through extended longevity.[8] Public health expenditure extends longevity if new medications for the treatment of diabetes and high blood-pressure are developed and if the working generations take these medications. Herein, we discuss the effects of public health expenditure on fertility.

For simplicity, we assume away the private medical research sector and any spillover effect of health expenditure. Similar to Bhattacharya and Qiao (2007), Osang and Sarkar (2008), Pestieau et al. (2008), Leung and Wang (2010), and others, we also assume that the probability of living into the old period is a function of public health expenditure, G_t^p. That is,

$$p_t \equiv p\left(G_t^p\right). \tag{12}$$

For analytical simplicity, following Osang and Sarkar (2008) and Leung and Wang (2010), we assume the following conditions: $0 < p < 1$, $p' > 0$, $p(0) = \bar{p}$ ($\bar{p}$ is constant), $0 < \bar{p} < 1$, and $\lim_{G_t^p \to \infty} p'\left(G_t^p\right) = 0$.

We suppose that the government budget constraint is decoupled and that dedicated taxes exist both for public health expenditure and social security benefits. We can consider the effect of a tax for public health expenditure (health tax) on fertility while maintaining a constant social security tax and that of social security tax with a constant health tax.[9] This discussion clarifies how parents' decisions to bear and care for children depend on public health expenditure and/or social security benefits.

The government budget constraints for the working generation at period t are given as

$$\tau_H w = G_t^p, \tag{13}$$

and

$$\frac{1+n_t}{p_{t-1}} \tau_s w = T_t. \tag{14}$$

For the following discussion, the government is assumed to predetermine the sequences of τ_H and τ_s for simplicity. We also note that $p(G_t^p) = p(\tau_H w)$.

[8] Although private health expenditure also has a direct effect on longevity, we do not discuss the spillover effects of public policy on private health care in this paper. Cigno and Pinal (2004) present evidence that public health expenditure crowds in private health expenditure in Argentina. However, the purpose of this paper is to discuss the effects of public health expenditure on fertility. The introduction of spillover effects of public health expenditure on private health expenditure makes it difficult for us to discuss how public health expenditure affects longevity and fertility. Thus, we assume the lack of private health expenditures in this paper.

[9] In economically developed countries, such as Japan, governments adopt an earmarked tax policy to finance public health insurance (expenditure) and social security benefits. Omori (2009) examines the respective effects of earmarked tax for social security and public education on fertility.

3. Optimal plans

In equilibrium, based on (10), (13), and (14), the optimal plan for the number of children, n^*, is as follows:

$$n^* = \frac{\epsilon w \left[(1-\tau_H)(1+r) - r\tau_s \right]}{(1+p(\tau_H w)+\epsilon)\Lambda(1+r) - \epsilon\tau_s w}. \tag{15}$$

This economy is regarded as a small open economy where the capital labor ratio, interest rate, and wage rate are constant. τ_H and τ_s are also assumed to be predetermined and fixed over time. Thus, public health expenditure, G_t^p, is fixed over time because of the government budget constraint of (13). Therefore, n^* is the time-invariant variable in equilibrium.[10] Moreover, because children are normal goods in this model, n^* must be positive. The denominator on the right-hand-side of (15) is assumed to be positive. We assume

$$(1+p(\tau_H w)+\epsilon)\Lambda(1+r) - \epsilon\tau_s w > 0. \tag{16}$$

Hereinafter, we discuss the policy effects on fertility by the evaluation of increments under the assumption that (16) holds. The variables in equilibrium are denoted with superscript $*$.

Similarly, rewriting (8), (9), and (11), the optimal plans for c_w^*, c_o^*, and s^* in equilibrium are shown by

$$c_w^* = \frac{w}{(1+p(\tau_H w)+\epsilon)} \left[\frac{(1+r)(1-\tau_H) - (r-n^*)\tau_s}{(1+r)} \right], \tag{17}$$

$$c_o^* = \frac{w}{(1+p(\tau_H w)+\epsilon)} \left[(1+r)(1-\tau_H) - (r-n^*)\tau_s \right], \tag{18}$$

and

$$s^* = \frac{w\left[p(\tau_H w)(1+r)(1-\tau_H-\tau_s) - (1+\epsilon)(1+n^*)\tau_s \right]}{(1+\delta+p(\tau_H w)+\epsilon)(1+r)}. \tag{19}$$

n^* is the time-invariant variable in equilibrium from (15), such that c_w^*, c_o^*, and s^* are also the time-invariant variables in equilibrium. We suppose that these variables are posi-

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[10] In Appendix A, we show the dynamical system when we introduce the labor-leisure choice into the model. That system is too complex to discuss the policy effects. For simplicity, we assume the lack of such choice but the path may not be essentially different from the one excluding such choice.

tive with the assumption that $(1+r)(1-\tau_H)-(r-n^*)\tau_s>0$ and $p(\tau_H w)(1+r)(1-\tau_H-\tau_s)-(1+\epsilon)(1+n^*)\tau_s>0$.

4. Health tax and social security tax

4.1 Health tax

4.1.1 Fertility

In this subsection, while holding the social security tax constant, we examine the effects of health tax on fertility. We differentiate (15) with respect to τ_H. That is,

$$\frac{dn^*}{d\tau_H}=\frac{(1+r)\left[-\epsilon w-n^*w\Lambda\frac{dp}{d\tau_H}\right]}{\left[(1+p(\tau_H w)+\epsilon)\Lambda(1+r)-\epsilon\tau_s w\right]}<0. \tag{20}$$

When the wage income tax rate for social security is constant, a higher health tax rate decreases fertility.

By contrast, from (19), the effects of health tax rate on saving is shown by

$$\frac{ds^*}{d\tau_H}=\frac{w\left\{(1+r)\left[-p+\left[(1-\tau_H-\tau s)-s^*\right]\frac{dp}{d\tau_H}w\right]-(1+\epsilon)\tau_s\frac{dn^*}{d\tau_H}\right\}}{\left[(1+p(\tau_H w)+\epsilon)(1+r)\right]} \tag{21}$$

In the numerator in (21), if $[(1-\tau_H-\tau_s)-s^*]\frac{dp}{d\tau_H}w-\frac{(1+\epsilon)\tau_s}{(1+r)}\frac{dn^*}{d\tau_H}>p$, $\frac{ds^*}{d\tau_H}$ is positive, and vice versa.

Therefore, these findings lead to the following proposition:

Proposition 1 *When the wage income tax rate for social security is constant, a higher health tax rate decreases fertility. Moreover, if*

$$\left[(1-\tau_H-\tau s)-s^*\right]\frac{dp}{d\tau_H}w-\frac{(1+\epsilon)\tau_s}{(1+r)}\frac{dn^*}{d\tau_H}>p, \tag{22}$$

such tax rate increases savings.

A higher tax rate decreases disposable income and fertility. An increasing health tax rate extends longevity and reduces the return in the annuity market. When the indirect effects of health tax on social security payments [the left-hand-side of (22)] is more than the direct effects on survival rate [the right-hand-side of (22)], such tax increases savings. Cutting the rising cost for children, they might save more to compensate for their decreasing lifetime income. Consumers do have an incentive to bear fewer children and need more savings for consumption in the old period.

However, when $[(1-\tau_H-\tau_s)-s^*]\frac{dp}{d\tau_H}w-\frac{(1+\epsilon)\tau_s}{(1+r)}\frac{dn^*}{d\tau_H}<p$, such tax decreases not only fertility but also savings because the tax effects on saving are too strong.

Similarly, from (17) and (18), the effects on consumptions are negative, as

$$\frac{dc_w^*}{d\tau_H}=\frac{w\left\{(1+p(\tau_H w)+\epsilon)\left[-1+\frac{\tau_s}{(1+r)}\frac{dn^*}{d\tau_H}\right]-\left[\frac{(1+r)(1-\tau_H)-(r-n^*)\tau_s}{(1+r)}\right]\frac{dp}{d\tau_H}w\right\}}{\left[(1+p(\tau_H w)+\epsilon)\right]^2}<0 \tag{23}$$

and

$$\frac{dc_o^*}{d\tau_H}=\frac{w}{(1+\delta+p(\tau_H w)+\epsilon)^2}$$
$$\times\left\{(1+\delta+p(\tau_H w)+\epsilon)\left[-(1+r)+\frac{dn^*}{d\tau_H}\tau_s\right]-[(1+r)(1-\tau_H)-(r-n^*)\tau_s]\frac{dp}{d\tau_H}w\right\}<0. \tag{24}$$

We note that $(1+r)(1-\tau_H)-(r-n^*)\tau_s>0$ is assumed. The effects on consumption are negative because increasing tax decreases disposable income.

4.1.2 Welfare

We examine the effects of health tax on welfare. We define the indirect utility function of generation t in equilibrium as

$$V^*=\ln c_w^*+p(\tau_H w)\ln c_o^*+\epsilon\ln n^*. \tag{25}$$

Although we have numerous welfare functions in the literature, as we suppose the small open economy and the variables in equilibrium are constant in this paper, we define the welfare function as (25). We derive the derivative of (25) with respect to τ_H as

$$\frac{dV^*}{d\tau_H}=\frac{1}{c_w^*}\frac{dc_w^*}{d\tau_H}+w\ln c_w^*\frac{dp}{d\tau_H}+p(\tau_H w)\frac{1}{c_o^*}\frac{dc_o^*}{d\tau_H}+\epsilon\frac{1}{n^*}\frac{dn^*}{d\tau_H}. \tag{26}$$

From *Proposition* 1, $\frac{dn^*}{d\tau_H}$ is negative. Based on (23) and (24), the welfare effects of a health tax are shown in the following proposition.

Proposition 2

If

$$w \ln c_w^t \frac{dp}{d\tau_H} > -\left[\frac{1}{c_w^*}\frac{dc_w^*}{d\tau_H} + p\left(\tau_H w\right)\frac{1}{c_o^*}\frac{dc_o^*}{d\tau_H} + \epsilon\frac{1}{n^*}\frac{dn^*}{d\tau_H}\right], \tag{27}$$

Consequently, a higher health tax rate increases welfare, and vice versa.

A higher health tax rate extends longevity, and agents enjoy consumption in the old period, as shown on the left-hand side of (27). Such conditions are called positive welfare effects. However, as previously discussed, such a tax rate decreases fertility and consumption. Lower fertility decreases social security benefits. Increasing the health tax rate generates negative welfare effects, where agents do not enjoy consumption and having children, as shown on the right-hand side of (27). Therefore, when the former effect is greater than the latter effect, a higher health tax rate increases welfare, and vice versa. We can show that we enjoy enhanced welfare even in an economy with declining fertility.

4.2 Social security tax

4.2.1 Fertility

We discuss the effects of a social security tax on fertility while holding the health tax constant.

We derive the derivative of (15) with respect to τ_s as

$$\frac{dn^*}{d\tau_s} = \frac{\epsilon w\left\{-r + \frac{[(1+r)(1-\tau_H)-r\tau_s]}{[\Lambda(1+\delta+p(\tau_H w)+\epsilon)(1+r)-\epsilon\tau_s w]}\right\}}{\left[\left(1+p\left(\tau_H w\right)+\epsilon\right)\Lambda\left(1+r\right)-\epsilon\tau_s w\right]}. \tag{28}$$

In particular, considering the numerator on the right-hand-side of (28), if

$$r > \frac{\left[\left(1+r\right)\left(1-\tau_H\right)-r\tau_s\right]}{\left[\Lambda(1+p(\tau_H w)+\epsilon)(1+r)-\epsilon\tau_s w\right]} = n^*, \tag{29}$$

$\frac{dn^*}{d\tau_s} < 0$, and vice versa.

From (19), we show the effect of social security tax on saving as

$$\frac{ds^*}{d\tau_s} = \frac{-w\left\{(1+r)p(\tau_H w) + (1+\epsilon)\left[(1+n^*) + \tau s\frac{dn^*}{d\tau_s}\right]\right\}}{\left[(1+\delta+p(\tau_H w)+\epsilon)\,(1+r)\right]}. \tag{30}$$

From the numerator on the right-hand side of (30), when $r > n^*$, if $(1+\epsilon)(1+n^*) + (1+\epsilon)\tau s\frac{dn^*}{d\tau_s} < -(1+r)p(\tau_H w)$, $\frac{dn^*}{d\tau_s}$ is positive. Therefore, we can show the following proposition:

Proposition 3 *When the wage income tax rate for public health expenditure is constant, if $r > n^*$, a higher social security tax rate decreases fertility. Moreover, if r is more than n^* and*

$$-(1+r)p(\tau_H w) > (1+\epsilon)(1+n^*) + (1+\epsilon)\tau s\frac{dn^*}{d\tau_s}, \tag{31}$$

then such tax increases savings.

A higher social security tax rate increases social security benefits. Such effect on benefits is reflected in n^*. In this model, we presume an unfunded social security system. When the private interest rate in the annuity market is more than that in tax effects, a higher social security tax decreases the income for the old generation. Consequently, extended longevity decreases social security benefits, such that the working generation requires more savings for consumption during the old age as shown in the left-hand side of (31). However, because rearing children entails cost, consumers have an incentive to decrease the number of children they want to have, which affects the social security benefits on the right-hand side of (31). If the former effects are stronger than the latter, the effects of social security tax on lifetime income will cause agents to save more.[11]

By contrast, when r is less than n^*, a higher social security tax rate increases fertility and decreases savings.[12] In this case, because a higher social security tax rate increases the lifetime income, consumers can compensate for the child-raising cost with cutting their savings.

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[11] If the former effects are less than the latter, such tax decreases savings because of the strong tax effects.

[12] As $\frac{dn^*}{d\tau_s} > 0$ and $(1+r)p(\tau_H w) + (1+\epsilon)(1+n^*) + (1+\epsilon)\tau s\frac{dn^*}{d\tau_s} > 0$ is negative.

Finally, based on *Proposition* 3, when r is more than n^*, the tax effects on consumption are negative, as

$$\frac{dc_w^*}{d\tau_s} = \frac{w\left[\tau_s \frac{dn^*}{d\tau_s} - (r - n^*)\right]}{(1 + p(\tau_H w) + \epsilon)(1 + r)} < 0, \tag{32}$$

and

$$\frac{dc_o^*}{d\tau_s} = \frac{w\left[\tau_s \frac{dn^*}{d\tau_s} - (r - n^*)\right]}{(1 + p(\tau_H w) + \epsilon)} < 0. \tag{33}$$

We note that, when $r < n^*$, $\frac{dc_w^*}{d\tau_s}$ and $\frac{dc_o^*}{d\tau_s}$ are positive.

4.2.2 Welfare

Finally, we examine the welfare effects. We derive the derivative of (25) with respect to τ_s as

$$\frac{dV^*}{d\tau_s} = \frac{1}{c_w^*}\frac{dc_w^*}{d\tau_s} + p(\tau_H w)\frac{1}{c_o^*}\frac{dc_o^*}{d\tau_s} + \epsilon\frac{1}{n^*}\frac{dn^*}{d\tau_s}. \tag{34}$$

As *Proposition* 3 shows, $\frac{dn^*}{d\tau_s}$ is negative when $r > n^*$. From (32) and (33), if $r > n^*$, $\frac{dc_w^*}{d\tau_s}$ and $\frac{dc_o^*}{d\tau_s}$ are also negative. We present the following proposition:

Proposition 4 *If $r > n^*$, then a higher social security tax rate decreases welfare.*

As explained in *Proposition* 3, when r is more than n^*, a higher social security tax rate increases social security benefits but decreases fertility. The tax effects cause the agents to consume less. Therefore, if $r > n^*$, a higher social security tax rate decreases welfare.

Finally, if $r < n^*$, as $\frac{dn^*}{d\tau_s}$, $\frac{dc_w^*}{d\tau_s}$ and $\frac{dc_o^*}{d\tau_s}$ are positive, a higher social security tax rate enhances welfare because of the positive effects of tax on lifetime income.

5. Concluding remarks

As described in this paper, introducing public health expenditure and longevity into an overlapping-generations model, we studied how public health expenditure and social security affect fertility and welfare.

We presented two results. First, when the wage income tax rate for social security is constant, a higher tax rate for public health expenditure decreases fertility, but can enhance welfare. Second, at a constant wage income tax rate for public health expenditure, if the interest rate is more than the fertility rate, a higher tax rate for social security can decrease fertility and welfare.

Expanding longevity affects parents' saving behavior for their retirement. However, an additional child causes parents to affect their savings to cover the cost of having children. Social security benefits partly compensate for the savings cut and give parents an incentive to have more children. Public health expenditure, however, gives parents the incentive to bear fewer children. Therefore, public health expenditure extends longevity but decreases fertility. In an aging society, as public health policy accelerates the decline in fertility, we need to consider other public policies with social security to recover from the economy where fertility is declining.

Appendix A

When we introduce the labor-leisure choice into the model, our model is developed as follows: For the representative consumers of generation t, the utility function is

$$u\left(c_w^t,\ c_o^t,\ n_{t+1},\ l^t\right) = \ln c_w^t + p_t \ln c_o^t + \epsilon \ln n_{t+1} + \delta \ln l^t, \tag{35}$$

where l^t is the leisure for generation t. The budget constraints of a representative agent of generation t in the working and old periods are given respectively as

$$c_w^t + s^t + \Lambda n_{t+1} = \left(1 - l^t\right)\left(1 - \tau_H - \tau_s\right) w, \tag{36}$$

and

$$c_o^t = \left(\frac{1+r}{p_t}\right) s^t + T_{t+1}. \tag{37}$$

The government budget constraints for the working generation at period t are given as

$$(1-l^t)\tau_H w = G_t^p, \tag{38}$$

and

$$(1-l^t)\frac{1+n_t}{p_{t-1}}\tau_s w = T_t. \tag{39}$$

In equilibrium, the optimal plan for the number of children, n_{t+1}, is as follows:

$$n_{t+1} = \frac{\epsilon w\left[(1-\tau_H)(1+r) - (r+l^t)\tau_s\right]}{(1+\delta+p\left((1-l^t)\tau_H w\right)+\epsilon)\,\Lambda\,(1+r) - \epsilon(1-l^t)\tau_s w}. \tag{40}$$

Then, that for the leisure, l^t, is given by

$$l^t = \frac{\delta}{(1+\delta+p\left((1-l^t)\tau_H w\right)+\epsilon)}\left[1+\frac{(1-l^t)(1+n_{t+1}\tau_s w}{(1-\tau_H-\tau_s)w(1+r)}\right]. \tag{41}$$

These equations show the dynamical system in this model. However, when we do not consider the labor-leisure choice ($l^t = 0$ and $\delta = 0$), n_{t+1} on (40) is equal to n^* on (15). If we include the labor-leisure choice in this paper, the model is too complex to examine the effects of public policies on fertility and welfare. As the purpose of this paper is to discuss how public health and social security affect the fertility and welfare, for simplicity, we do not consider the labor-leisure choice, although the path may not be essentially different from the one excluding such labor-leisure choice.

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References

Anderson, T., 2005, Social security and longevity. CESifo WP No. 1577.

Becker, G. S., Barro, R. J., 1988, A reformulation of the economic theory of fertility. Quarterly Journal of Economics 103, 1–26.

Bhattacharya, J., Qiao, X., 2007, Public and private expenditures on health in a growth model. Journal of Economic Dynamics and Control 31, 2519–2535.

Bovenberg, L., Uhlig, H., 2006, Pension systems and the allocation of macroeconomic risk. Tilburg University, CentER DP 2006–101.

Chakraborty, S., 2004, Endogenous lifetime and economic growth. Journal of Economic Theory 116, 119–137.

Cigno, A., Casolaro, L., Rosati, F. C., 2003, The impact of social security on saving and fertility in Germany. FinanzArchiv 59, 189–211.

Cigno, A., Pinal, G., 2004, Endogenous child mortality, price of child-specific goods and fertility decisions: evidence from Argentina, In: Heymann, D., Navajas, N., Bour, E. (Eds.), Latin American Economic Crises, Palgrave Macmillan, London, U.K., 247–257.

Cigno, A., Rosati, F. C., 1992, The effects of financial markets and social security on saving and fertility behaviour in Italy. Journal of Population Economics 5, 319–341.

Cigno, A., Rosati, F. C., 1996, Jointly determined saving and fertility behaviour: theory, and estimates from Germany, Italy, UK, and USA. European Economic Review 40, 1561–1589.

Cigno, A., Rosati, F. C., 1997, Rise and fall of the Japanese saving rate: the role of social security and intra-family transfers. Japan and the World Economy 9, 81–92.

Diamond, P., 1965, National debt in a neoclassical growth model. American Economic Review 55, 1126–1150.

Ehrlich, I., Zhong, J. G., 1998, Social security and the real economy: An inquiry into some neglected issues. American Economic Review 88, 151–157.

Leung, M. C. M., Wang, Y. 2010, Endogenous health care, life expectancy and economic growth. Pacific Economic Review 15, 11–31.

Organization for Economic Co-operation and Development (OECD) 2010, OECD Health Data 2010, Paris, France.

Omori, T., 2009, Effects of public education and social security on fertility. Journal of Population Economics 22, 585–601.

Osang, T., Sarkar, J., 2008, Endogenous mortality, human capital and economic growth. Journal of Macroeconomics 30, 1423–1445.

Pestieau, P., Ponthiere, G., Sato, M., 2008, Longevity, health spending, and pay-as-you-go pensions. FinanzArchiv 64, 1–18.

Yakita, A., 2001, Uncertain lifetime, fertility and social security. Journal of Population Economics 14, 635–640.

Zhang, J., Zhang, J., 1998, Social security, intergenerational transfers, and endogenous growth. Canadian Journal of Economics 31, 1225–1241.

Zhang, J., Zhang, J., 2004, How does social security affect economic growth? Evidence from cross-country data. Journal of Population Economics 17, 473–500.

Zhang, J., Zhang, J., Leung, M. C. M., 2006, Health investment, saving, and public policy. Canadian Journal of Economics 39, 68–93.